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THE MODIFICATION OF INSTINCT FROM THE STANDPOINT OF SOCIAL PSYCHOLOGY

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In the discussion which follows I have attempted a relatively comprehensive statement of the modification of instinct with particular reference to the topic as incorporated in social psychology. The formulations have been made with reference to a statement of general principles rather than with a view to a summary of such experimental data as might be available. I think most social psychologists approach the topic of instinct with the feeling that while it should be of great importance, from an *a priori* standpoint, yet that the actual developments which the topic receives fail somehow to justify the expectation. Social psychology is, of course, as interested in the experimental facts concerning instinct as is normal human adult psychology, but it seeks more insistently to put the data together in a manner significant for the understanding of human nature so far as this is modified by its social environs.

In section I., I have sought merely a reformulation (possibly more detailed than usual) of the modification of instinct on its afferent or efferent sides, or on both simultaneously. This section is preparatory for those that follow. In sections II. and III., types of instinctive modification are considered which are new to social psychology and all but unsuggested in the other fields of general psychology. These sections discuss (1) the fact and significance of the temporal position of the modifications as occurring before or after the first

instinctive performance, and (2) the modification of the biological purposes of inherited responses.

I. Modifications of the Sensory and Motor Aspects of Instinct

Previous writers have attacked the question of the modification of instinct at three chief points: (*a*) indicating that an increase in perfection of response through practice does take place; (*b*) disentangling (partly) the separate rôles of maturation and use in the increasing perfection; and (*c*) pointing out that modifications concern either the stimulus or the response side of the instinct. It is this latter point that we wish to formulate in the present section.

Shortly after birth an individual will, through heredity, manifest the fear reaction upon the presentation of certain stimuli. By virtue of associations, these stimuli may later become ineffective and new stimuli be secured which were previously indifferent. Thus birds on desert islands show no fear of man until the frequency of his appearance, coupled with effective stimuli for fear, finally endows the perception of man himself with the capacity to arouse fear. Studies of the conditioned reflex are laboratory observations of this same phenomenon. The protective reflex of the finger, *e.g.*, has as its unconditioned (inherited) stimulus injury to the finger; but by a frequent simultaneous presentation of sound and injury, sound also becomes an effective stimulus producing withdrawal of the finger. The internal mechanism of this need not concern us in the present discussion. It should be stated, however, that habits as well as inherited forms of response are susceptible to this type of modification, the distinction being that we deal with conditioned reflexes directly when the changes effected are made from the original stimulus rather than from stimuli which in themselves may be one or more removes from the hereditary status of the response.

From the side of changes in effector activities proper, the same statements are true although the term conditioned reflex seems not to have attached to such modifications,

undoubtedly due to the accident governing the choice of laboratory procedure. The protective reflex and the salivary reflex, *i.e.*, the effector activities proper, have been kept constant in such studies and experimentation directed toward the analysis of stimulus changes. However the physiological changes effected are presumably no different from those which occur in the contrary case when experience changes the type of response while the stimulus remains constant. The illustrations of this are legion. One may cite the changes which occur in the "expression" of fear and anger as the human individual matures in a social environment, or one may consider the modifications which occur in animal behavior during the process of learning. In the latter case, a total situation is presented to a white rat placed in a visual discrimination box, calling forth exploratory movements; but under the influence of punishment, reward, and frequency, the exploratory movements are inhibited and give way to well-defined food responses. One may state such an outcome either as the inhibition of an instinctive response to a given stimulus by acquired responses, or as the acquisition by the food-getting response of a new stimulus. Perhaps both are involved.

The social values of the above types of change in instinct have been so widely recognized that we need not elaborate the problem further. This is not true, however, in the case of those modifications termed sublimations. The sublimation of instinct in the human individual is an example of the simultaneous modification of the afferent and efferent phases of the response. Anger becomes righteous indignation by the substitution of a new and (in this case) an ideal stimulus for the sensory (animal) one and by the conversion of the gross bodily attack into the response of denunciation, purchasing Liberty Bonds, or longer hours of labor. Sex impulses may be sublimated in artistic activity, in dancing, in religious activity, or, when joined possibly with the parental impulse, in social service. Instances of sublimation are those where the inherited impulses are placed at the service of activities which bear little or no resemblance to the activity

which normally embodies the impulse. The cases are not due to the suppression or elimination of the instinct in its entirety; only the somatic, skeletal responses are inhibited while the visceral continue probably at full intensity. The individual may entirely fail, and usually does fail, to identify the persistent behavior complex, because to the uninitiated, instincts are identified in terms of their somatic components. *It is this difficulty of identification which permits the sublimation to proceed unimpeded by emotional conflict, and unthreatened by the failure which would almost surely be its lot did the subject realize the origin of his impulses in their proper (unconditioned) instinct.*

Although the non-technical use of sublimate means to purify, or to idealize, the preceding analysis would indicate that the physiological mechanisms involved need not include the equivalent of ideals. The stimuli for artistic activities, for dancing, for charity and social service may be as concrete as for the arousal of any other form of modified instinctive performance. The presence of syncopated music and members of the opposite sex initiates dancing, and the awareness of suffering and poverty calls out charitable relief in those individuals possessing the sublimated behavior. And so, although one would hesitate to apply this term to animals below man, the understanding of instinctive modifications is better when one realizes the essential continuity of the phenomena. Thus a dog can by training be made angry by whistling, and the instinct can then be modified on its effector side by training the dog to vent his pugnacity in some unusual manner. Behavioristically, the instinct is as trully sublimated as in man, although the social significance of the change may be infinitesimal.

It is proper that we should place beside the above statements the following remarks by Woodworth[1]:

"Freud's 'sublimation' is an attractive concept. It is 'nice' to believe that crude motives, that cannot be allowed their natural outlet, can be drained off into other activities, so that a libidinous infatuation, sluiced out of its natural

[1] Woodworth, R. S., 'Dynamic Psychology.' New York: 1918, p. 175–6.

channel, can be made to drive the wheels of an artistic or humanitarian hobby. But there is no clear evidence that this can be accomplished. What does happen sometimes is that, in the effort to escape from, and distract oneself from a strong but unwelcome impulse, one turns to some other activity capable of enlisting interest; and, since the unwelcome impulse is not easily resisted, one has to become as absorbed as possible in this other activity. Under such conditions, interest in this other activity may grow into a strong motive force and effectually supplant the unwelcome impulse. But this is distinctly not making the unwelcome impulse do work foreign to its own tendency. This impulse is not drawn into service, it is resisted. If there were no other and contrary motive force, the impulse in question would have its own way. We did see that the tendency towards a 'consummatory reaction' acted as the drive to other mechanisms, but these were mechanisms that subserved the main tendency, whereas 'sublimation' would mean that the tendency toward a certain consummation could be made to drive mechanisms irrelevant or even contrary to itself. There seems to be really no evidence for this, and it probably is to be regarded as a distinctly wrong reading of the facts of motivation."

We must agree with Woodworth that compelling evidence of sublimation is difficult to secure. We do believe however that the psycho-analysts have made a good case for its existence; and when we remember the introspective difficulties besetting the identification of visceral components of response and of minor somatic responses in general, we are tempted to conclude that the case will always lack that clear-cut evidence which is desirable. However, the James-Lange theory of emotion meets the same type of difficulty and yet has managed to survive its severest critics because of the intrinsic merit of its claims. We shall indicate schematically in a following paragraph how the neural processes may proceed in sublimation; but here, in the light of Woodworth's remarks, renewed emphasis should be placed upon points already stressed.

1. Sublimations do not arise suddenly in an effort to control an unruly impulse that is recognized as undesirable;

they are the end-products of modifications whose formation has probably extended over several years. The behavior which may be said to undergo this modification may indeed never make its actual appearance, due to the fact—which we shall emphasize later in the paper—that certain habits or customs have been fixed upon the individual before the normal time for the instinct to appear. Therefore when the instinct manifests itself, it does so from the very beginning in modified form.

2. The visceral responses which constitute the physical basis of the impulse and emotion of the sublimated behavior can be identified by skilled introspection as closely similar to the visceral core (or "feel") of the unsublimated form of the response. Indeed this is a chief reason for insisting that such behavior as righteous indignation, *e.g.*, is a refined and derived form of animal anger. Or again, the alleged similarity of the emotional quales is a prominent reason for the insistent attempts to identify the sex and religious activities.

3. One need not assume, as Woodworth does, that in sublimated forms of behavior the "drive" does only work foreign to its natural purpose. On the contrary, an introspective description of the cases would suggest that, did we have adequate recording methods, widespread visceral and somatic responses would be found present at low intensity in contrast to the high intensity marking the untransformed behavior. What is important is that the behavior initiated by the sublimated impulse shall not impress the observer as a surviving (or anticipating) part of the original instinct. The uninitiated subject may only feel the restlessness due to visceral changes without recognizing in any degree the total response to which this restlessness normally belongs. He may therefore proceed to make use of this impulsive tendency in some socially acceptable behavior, the frequent repetition of which may constitute his idiosyncracy or even his profession. We shall see later that many instinctive impulses may be made to work out purposes other than those for which the instinct was apparently designed. In sublimation the situation is the same, a behavior component becomes trans-

ferred from one total response to another through the so-called conditioned reflex type of association and so does duty in the service of a purpose not originally its own.

A formulation in terms of the neural diagram of Fig. 1 may help give definiteness to the preceding account. In-

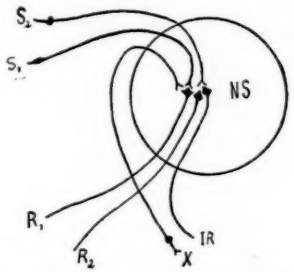

FIG. 1. Schematic representation of the neural elements involved in the modification of instinct. *NS*, the central nervous system. S_1, the original stimulus; S_2, an acquired stimulus; R_1, the original somatic response; R_2, a new or modified somatic response; *X*, the visceral sensory component of the stimulus; and *IR*, the internal, or visceral, response. The mutual relations of these elements are discussed in the body of the paper.

stincts belong to either of two classes: those having a conspicuous visceral component in the stimulus and those that do not. This visceral component corresponds on the physiological side to the appetite or desire prominent in food-getting and sex, *e.g.*, relatively absent in fear and anger, and totally absent in the simpler instincts (reflexes) of walking, standing, grasping, and even in such responses as collecting, curiosity, and others. This visceral component is represented in the figure by *X*. Normally the instinctive behavior R_1 is produced by the unconditioned stimulus S_1 acting alone or in conjunction with internal stimulus *X*. In many cases these afferent conditions also produce visceral effects, *IR*. Modifications of this original inherited equipment, so far as the elements of the neuro-physiological mechanisms are concerned, may be thought of in any one of the following ways, or in combinations of these: (1) S_2 acting alone or in conjunction with *X* may by use become an effective stimulus for the responses R_1 (somatic) and *IR* (visceral). The

organism now fears some new object, has adopted some new article of diet, or (as is beautifully illustrated for animals below man in Craig's work with pigeons) has acquired some new sexual object. The internal appetite is still present, the responses of the skeletal muscles are unmodified, the visceral effects underlying the consciousness termed emotion are in full vigor, only the external stimulus has changed, although it may have changed to something which no longer suggests S_1 to the experiencing subject. (2) S_1, in the cases where by heredity the coöperation of X is necessary to give the afferent activity control of the final common path to R_1 and IR, may by use secure the power to arouse R_1 when X is absent. Here belong the cases where an instinct is aroused in the absence of the normal appetite or desire, jaded instincts, in a word. (3) Modification 2 may occur after S_2 has become the effective stimulus. (4) By use, or through the absence of the proper S, X may become so vigorous, so intense, so voluminous, that in the absence of an effective S, or even of any discoverable S, it may secure possession of the final common path to R_1 and IR. As examples we may cite: Breed's chicks, when they gave the drinking reaction in the air with no observable outside stimulus present; the case of a starving man or one perishing with thirst who swallows totally inadequate and normally non-effective stimuli; unreasoning, groundless fears; and finally cases of gluttony, alcoholism, and abnormal sex hunger. (5) S_1 or S_2 may by practice secure the power to arouse R_1 not only in the absence of X but without involving any noticeable visceral changes, IR. This is the instinctive behavior devoid not only of normal appetite but of the normal emotional satisfaction which accompanies its exercise. Again the most striking illustrations come from the field of food and sex responses. (6) The modification of the instinct may proceed with S_1 and X unchanged but with the response shifted from R_1 to R_2,—or from a clumsy and unskilled R_1 to an efficient performance of the same response (as, *e.g.*, in Breed's experiments). Again it should be noted that R_2 may be so different from R_1 that an observer not knowing the genetic facts would be

unable to detect a relationship between the two activities. (7) The final case of modification occurs when the effects of practice, or use, have substituted S_2—R_2 for the original behavior with or without abnormality in X and IR. These are the typical cases of sublimation; and, if X and IR are unmodified, they are the cases where the desires and emotions (satisfactions) of one original response are put at the service of, or incorporated into, derived forms of behavior. Stated in this manner and placed in relation to other forms of stimulus and response changes, sublimation loses any mystical character it may have been thought to include and stands forth as a peculiarly important type of the modification of instinct.

II. The Temporal Position of the Modifications

So far our analysis has concerned those phases of instinctive modification which can be formulated in terms of change in the elements of the stimulus-response situation. Two other problems now remain to be emphasized, problems which although of fundamental importance in the modification and control of behavior are unnoticed in the social psychologies, and are at the best treated only by implication by the technical students of instinct. These problems are: (1) The temporal position of the modification, whether coming prior or subsequent to the first instinctive performance; and (2) modifications of the biological purpose, or end, involved in the inherited behavior.

The modifications of instinctive performance are not all variations (of the stimulus, of the somatic response, or of the visceral response) produced after the instinct first appears. Instances which do belong here we have already illustrated. Other modifications occur because of influences at work before the instinct makes its initial appearance. These changes will clearly affect the instincts in proportion to the length of the interval between birth and the instinct's appearance and in proportion to the social value inherent in a modification of the instinct in question. The dates and order of the appearance of the various instincts are sufficiently known

to serve our present general purpose. Figure 2 indicates for man the early appearance of the responses of feeding, fear, anger, and vocalization, the final appearance of the sex and parental responses, and the intermediate appearance of such responses as play, acquisition, locomotion, construction, etc. We do not mean to imply by the use of this diagram any more

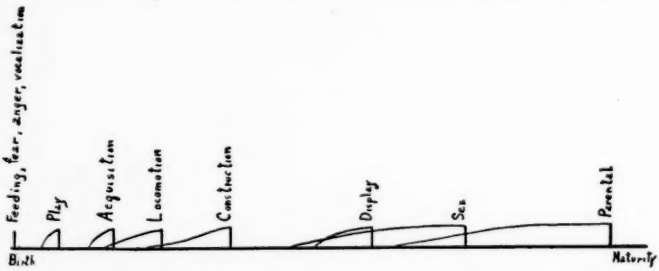

FIG. 2. Diagram indicating: the early appearance of the instincts of feeding, fear, anger, and vocalization; the intermediate appearance of such instinctive responses as play, acquisition, locomotion, etc.; and the late appearance of sex and parental behavior. The curves for each instinct suggest the appearance of component elements before the complete instinct matures and is active. No emphasis is to be placed either upon the relative order of the intermediate instincts or upon the form and length of the several curves.

than concerns our immediate purpose. The instincts and instinctive tendencies in man are as a rule too indefinite in their manifestations to enable a very satisfactory listing, and the question of their temporal order of appearance is one calling for much additional experimental work. Particularly is it important for the problem of the modification of instinct that the early traces be noted of instincts which appear late.

Our very simple diagram (Fig. 2) enables us to visualize clearly the possibility of the temporal aspects of the modifications above mentioned. It also serves to suggest that the instincts which will be most open to change by virtue of preëxperience will be the ones listed farthest to the right. Feeding, fear, and anger, *e.g.*, appearing as they do practically at birth, offer no other possibility than modifications subsequent to their appearance; while the temporal interval antedating sex, *e.g.*, makes possible the acquisition of many

responses which will serve to modify (and control) that instinct.[1]

Although our chief interest does not lie in the historical aspects of our subject, it will be worth while to indicate the types of comment and experiment already available in the literature so far as they may concern the modification of instinct by preëxperience. We derive the first suggestion from the writings of Karl Groos on play (1895) where the following statements occur:[2]

". . . there can be no doubt that instinct plays a part in all this adaptation for the struggle for life and preservation of the species, so necessary in man and other animals. Further . . . it would be entirely in harmony with other phenomena of heredity if we found that these instincts appear at that period of life when they are first seriously needed. Just as many physical peculiarities which are of use in the struggle for the female only develop when the animal needs them; just as many instincts that belong to reproduction first appear at maturity; so the instinct of hostility might first spring up in the same manner only when there is real need for it; and so it might be supposed with other instincts in connection with related activities. The instinct for flight would only be awakened by real danger, and that of hunting only when the animal's parents no longer nourished it, and so on. In this case it would be necessary for the special instincts to be elaborated to their last and finest details. For if they were only imperfectly prepared, and therefore insufficient for the real end, the animal might as well enter on his struggle for life totally unprepared. . . .

"Without play practice it would be absolutely indispensible that instinct should be very completely developed, in order that the acts described might be accurately performed

[1] In what follows we shall have much to say concerning sex behavior, but this must in no way be interpreted as an adoption of the Freudian point of view that sex is the dominant instinct. Our emphasis upon this response results because (*a*) of the strength of its impulse, (*b*) of the lateness of its appearance, and (*c*) of the fact that it assumes a more definite instinctive form than other late instincts.

[2] Groos, Karl, 'The Play of Animals.' Eng. trans. by Baldwin. New York: 1898, pp. 73–4; 79.

by inherited mechanism, as is also the case with such instinctive acts as are exhibited but once in a life time."

". . . instincts are not so perfectly developed, not so stamped in all their details on the brain, as they would have to be if their first expressions were to be serious acts. Therefore they appear in youth, and must be perfected during that period by constant practice."

One need not accept Groos's theory of play in order to admit the essentials of the above quotations. There is a playful exercise of those elements of an instinct which appear prior to the complete appearance of the inherited behavior, and this exercise does, by the law of habit, have an effect upon subsequent arousals.

Lloyd Morgan, writing in 1900, speaks much more definitely on our present problem:[1]

"Even in the case of the very first exhibition of such a deferred instinct as the moor-hen's dive, although that organized sequence of acts which constituted the behavior as a whole had never before occurred, although there was no gradual learning how to dip beneath the surface, and to swim under water, still many of the constituent acts had been often repeated; experience had already been gained of much of the detail then for the first time combined in an instinctive sequence. So that if we distinguish between instinct as congenital and habit as acquired, we must not lose sight of the fact that there is continual interaction, in a great number of cases, between instinct and habit, and that the first performance of a deferred instinct may be carried out in close and inextricable association with the habits which, at the period of life in question, have already been acquired."

This point of view Morgan continues to discuss down to 1912,[2] without, however, so far as I am aware, commenting upon its social significance or attempting any general analysis of the problem. I can find no discussion of this temporal aspect of the modification in the current textbooks of psy-

[1] Morgan, C. Lloyd, 'Animal Behavior.' London: 1900, p. 106.

[2] Morgan, C. Lloyd, 'Instinct and Experience.' New York: 1912, chs. 1 and 2.

chology, nor in the social psychologies[1] and more special treatises on instinct and behavior. Undoubtedly in the observational literature on instincts many instances could be unearthed. We shall cite but one, perhaps the best one, however, and then proceed with our comments on the general problem.

This illustration is drawn from the work of C. O. Whitman on pigeons, and is as follows:[2]

"If a bird of one species is hatched and reared by a wholly different species, it is very apt when fully grown to prefer to mate with the species under which it has been reared. For example, a male passenger-pigeon that was reared with ring-doves and had remained with that species was ever ready, when fully grown, to mate with any ring-dove, but could never be induced to mate with one of his own species. I kept him away from ring-doves a whole season, in order to see what could be accomplished in the way of getting him mated finally with his own species, but he would never make any advances to the females, and whenever a ring-dove was seen or heard in the yard he was at once attentive."

("It may be remarked by the editor that the discovery of this principle furnishes the key to Professor Whitman's success in hybridizing the various species of pigeons. A novel and important principle of behavior is here involved. The range of stimuli to which an instinctive tendency will respond may be modified by habits acquired long before the first expression of the instinct. The first expression of a delayed instinctive tendency may thus be in part a function of all that the organism has previously acquired.")

While we cannot agree with Carr that the principle of behavior involved in Whitman's work is novel, yet we must agree that it is important far beyond any recognition yet

[1] Baldwin skirts the edge of the problem in his account of social heredity as developed in "Social and Ethical Interpretations," New York: 1906, 4th edition, Pt. 1, ch. 2; but he seems not to have stated explicitly that social heredity may get in its work on the individual before the instinct (physical heredity) has appeared in that individual.

[2] Whitman, C. O., 'Orthogenetic Evolution in Pigeons,' Vol. 3, 'The Behavior of Pigeons.' Edited by Harvey Carr. *Carneg. Inst. Washington, Publ.* No. 257, 1919, p. 28. I have added Carr's editorial comments in parenthesis.

given it. This modification of instinctive behavior by experience encountered prior to the first appearance of the inherited response may be conceived in any of the following ways: (1) The early appearance of component elements of the final total behavior (as indicated by the curves of Fig. 2) may involve their own modificaton on the basis of use in such a manner that when the total instinctive response appears it does so in a manner not entirely determined by heredity. This modification may be either on the stimulus or on the motor side of the early appearing tendencies, and is in this respect a case under section I. of this paper. This would be the type of case covered by Groos's theory of play and by Morgan's description above quoted. (2) Perhaps independently of any early component tendencies of later instincts, the individual may be instructed in the nature of the socially accepted stimuli and forms of response so that when occasion arises he will respond in the socially accepted manner.[1] So thorough and far reaching may these modifications be, that the individual may never know the animal form of the instinct; and yet we must believe that this persists, in the form perhaps of synaptic connections, because something very like it appears when the bonds of social restraint are relaxed.[2]

The responses of feeding, fear, and anger, as we have said, appear too early in the individual's life for this general type of modification; but such responses as play, constructiveness, sex, display, and the parental instinct, occurring later, offer the individual and the social group an opportunity to determine prior to the onset of the behavior the stimuli which

[1] This instruction which precedes the maturing of relevant interests is undoubtedly very uneconomical from the standpoint of the laws of learning; but the vital problem is not the speed and efficiency of the acquisition, it is rather the mere fact of acquisition, the importance of building up controls while the organism is yet young.

[2] It seems hardly believable, in view of this last fact, that any psychologist should deny that man possesses true instincts. Present-day society has so modified the individual and his environment, that the individual seldom experiences the sheer animal form of the response—indeed some may never do so. However, occasionally in moments of great stress, the individual is literally swept off his feet by a gust of animal-like passion. Perhaps once or twice I have approached such an experience. My own testimony would be that in such a case one is for the moment an all but unconscious automaton.

shall ordinarily arouse it and the form which it shall take. Play activities vary in their content in dependence upon the social environment, as do constructiveness and sex also. Long prior to the maturing of the latter instinct and even longer before its usual manifestation, society has set before the individual a pattern which, like the Great Stone Face of Hawthorne's tale, shall serve more or less unconsciously to instruct and guide him in the accepted stimuli and responses of that behavior. Religious training likewise can, and does in many cases, take the young individual and so shape his religious symbols and responses that when religious activities do appear definitely in adolescence, it shall seem but natural to turn to one sect or one religion for their gratification. Society in this type of modification is giving the individual the benefit of its own experience, not by permitting the instinct to manifest itself in the crude animal form and then modifying it, but by building up the proper controls prior to the emergency.

III. Modifications of the Biological Purpose

The final problem which we have set ourselves is now at hand. Modifications of the instincts are not only of the sorts which have been outlined above, but they may involve essential changes in the biological purpose of the response. By the biological purpose of an instinct, I mean the adaptive purpose which it secures or tends to secure. Thus the biological end in view in the case of fear is the removal of the organism from the dangerous stimulus; in the case of anger, it is the injury of the offending object; in sex, it is the reproduction of the species, etc. There is, as I understand, no dispute on this point, viz., that instincts are adaptive forms of response. This statement carries no implication that the purpose is a conscious one or that it has been instrumental in molding the behavior. The statement is a straightforward, scientific, objective formulation, implying nothing of vitalism or of other speculative interpretations of the place of purpose in nature.

Inasmuch as the animals below man give as yet no evi-

dence of possessing the behavior equivalent of thought processes, it is a probable assumption that they never possess an awareness of the purpose of their acts. At some time in the evolution of man, therefore, the consciousness of the purpose served by his responses has appeared. At first, undoubtedly, only the more obvious purposes have been grasped, such as those found in the protective reflexes, in hunting, in display, and in parental behavior. Particularly in the case of the sex instinct there is reason to believe that the race has only recently, *i.e.*, recently as one estimates time in terms of man's existence on the earth, discovered the connection between the sex instinct and reproduction. By way of illustration, we may quote from Spencer and Gillen's account of the tribes of Central Australia. Writing in 1899, they say:[1]

". . . we have found amongst the Arunta, Luritcha, and Ilpira tribes, and probably also amongst others such as the Warramunga, the idea firmly held that the child is not the direct result of intercourse, that it may come without this, which merely, as it were, prepares the mother for the reception and birth also of an already formed spirit child who inhabits one of the local totem centers. Time after time we have questioned them on this point, and always received the reply that the child was not the direct result of intercourse."

Writing again in 1904, they say:[2]

"Indeed Mr. Roth's latest work in Queensland shows clearly that the idea of spirit children entering women, and that sexual intercourse has nothing to do with procreation, is a very widespread belief amongst the Australian aborigines, and is by no means confined to the tribes amongst whom its existence was first described by us" (p. xiii).

"The cermonies [of initiation] can never have had any reference directly to procreation, for the simple reason that the natives, one and all in these tribes, believe that the child

[1] Spencer, B. and Gillen, F. J., 'Native Tribes of Central Australia.' New York: 1899, p. 265.

[2] Spencer, B. and Gillen, F. J., 'Northern Tribes of Central Australia.' New York: 1904, Pp. xiii and 330–331.

is the direct result of the entrance into the mother of an ancestral spirit individual. They have no idea of procreation as being directly associated with sexual intercourse, and firmly believe that children can be born without this taking place. There are, for example, in the Arunta country certain stones which are supposed to be charged with spirit children who can, by magic, be made to enter the bodies of women, or will do so of their own accord. Again, in the Warramunga tribe, the women are very careful not to strike the trunks of certain trees with an axe, because the blow might cause spirit children to emanate from them and enter their bodies. They imagine that the spirit is very minute,—about the size of a small grain of sand,—and that it enters the woman through the navel and grows within her into the child."

In all cases a definite and accurate formulation of the adaptive value of the behavior has waited upon a clear perception of cause and effect relations among objects and events, which in many cases means waiting upon scientific analysis. Until the individual and society know the biological purposes of instincts, only accident can identify the purposes which society approves and fosters with those which heredity is seeking. But once this knowledge is forthcoming, society and the individual may proceed consciously and definitely to foster the purpose, or they may change the environment in such a way that the biological purpose can give way to a new purpose, or, finally, the biological purposes may be satisfied incidentally so far as the conscious plans of the individuals are concerned.

Nor should the present type of instinctive modification be confused with the voluntary exercise of a response that may at times be automatic and inherited. Such a case would occur when one winks voluntarily at a joke, and so might apparently be said to have modified the biological purpose of protection normally subserved by this response. In order to subsume the winking response under this third type of modification, the winking would have to be produced by the individual's voluntarily placing himself in front of a

stimulus which would automatically bring about the response and then for a social purpose which might or might not be the same as the biological one. Perhaps in the last analysis so-called voluntary activity is precisely of this nature, consisting of a highly elaborated conditioned reflex whose stimulus is an idea. But for the purposes of the present discussion there is an active participation and a feeling of control in voluntary activity which contrasts strikingly with the automatic, impulsive, compelling characteristic of the instinctive response (characteristics which are as definitely present when the instinct is "used" for social purposes as they are when it accomplishes purely biological ones).

The two great modifications which have been made in biological purposes appear to be these: (1) purposes which are inimical to civilized social life are supplanted by new and more acceptable ones; and (2) the biological purposes in all of the more powerful instincts are occasionally or habitually secondary to the use of the instinctive behavior as a pleasure giver. To be sure, in so far as the original synaptic connections persist—and it is my opinion that they are rarely if ever lost—the original biological end of the behavior will tend to remain and be satisfied, although perhaps only surreptitiously.

Table I has been drawn up with reference to the two types of cases suggested above. Here an attempt is made to state the biological purposes subserved by certain of the instincts and to place over against these the recognized social purposes which usually or occasionally dominate them. In some cases the two will be identical, due at times to accident and at times to foresight. The principle involved in this third type of modification of instinct is not dependent for its validity upon the accuracy of the analysis of Table I.; it is dependent rather upon the fact of variation between the two types of purpose whose detailed nature is there suggested.

There are certain features of Table I. which invite definite comment. In column three I have placed only what have seemed to be social purposes that are widely recognized in social practice. No attempt has been made to indicate

TABLE I

Instinct	Biological Purpose	Social Purpose Definitely Fostered
Anger	Defense of organism by removing offending object.	*Used in hostility and competition to stimulate great endeavor. Put at service of customs.
Fear	Defense of organism by removing it from offending environment.	*Used for taboos in maintenance of social organization.
Acquisitiveness	Accumulation of food and nest supplies.	*Accumulation of objects possessing general value or power to satisfy human wants. Fostering prestige.
Vocalization	Stimulation of certain instincts and habits in associates.	*Communication of ideas; stimulation of any instinct or habit in *self* or others.
Hunting	Securing of food and mates.	*Recreation, health, and prestige.
Rivalry	Domination, particularly in sex and play activities.	*Domination in all fields of activity.
Feeding	Nourishment.	*Nourishment, pleasure, and social solidarity.
Sex	Reproduction.	Pleasure, and reproduction. Begetting of offspring in order that parents may be cared for in sickness and old age.
Parental	Protection of young.	*Protection of young.
Display	Sex excitant, arousal of fear in others.	*Sex excitant, arousal of fear in others, prestige, creation of caste.
Religious	Protection from "Great Danger."	Protection from "Great Danger," protection of morals, social service.

The * indicates that biological purpose is not specifically combated.

Present occidental society fosters all instincts in some degree for health and pleasure as well as for the social purposes above enumerated.

the vast multiplicity of purposes for which the instincts may on occasion be used. With the appearance in man of ideational processes and ideational methods of behavior control, it has become possible to use the instincts not for their biological ends alone but for almost any end that the manipulator may have in mind. The demagogue and the propagandist by placing certain stimuli before the crowd may utilize the resultant fears, angers, acquisitivenesses, or religious activities to satisfy ulterior purposes of much or little merit. This is a matter of great social importance, but what we have indicated in the table differs in at least two vital ways from

the uses of instinct made by the individual social manipulator. In the first place, the social purposes or utilities there listed are definitely sanctioned by present occidental society; and in the second place, the individual in whom the instinct manifests itself may be, and usually is, well aware of the social purpose to be attained, inasmuch as much social or group effort is directed toward instructing him on this very point.

So far as our analysis can reveal, the social purposes permit the accomplishment in a more or less incidental manner of the biological purposes without any attempt to combat these purposes save in the case of the sex instinct and the religious tendency. In the hunting instinct, *e.g.*, the purposes of recreation, good health, and prestige are not incompatible with the food- and mate-getting end; nor does society repress the latter. The occasions on which the instinct appears may be limited by law, but when it does appear the biological end to be attained is laudable. This is true also in the cases of fear, anger, and the other responses whose social purposes are indicated with an asterisk. Society definitely favors the use of display (in clothing and physical prowess) as a sex excitant as well as an enhancer of prestige and a creator of class distinction. The original form of the stimulus and response is usually modified, and sublimated instincts may have been added to the complex, but when the instinct appears its biological purpose is approved. In the case of the religious tendency, on the other hand, society is tending to negate the biological purpose of protection from *great danger* or the *mysterious threat* (or however one may formulate the unseen characteristic of objects with which primitive man seeks to get *en rapport* through definite religion and magic).[1] In its place it is putting social service and the maintenance of moral conduct as the proper goal of the religious impulse. The change is not that of stimulus and response or of the accretion of other instinctive impulses alone, nor is it a limitation of the

[1] I do not know, of course, that this is the biological purpose, nor am I certain that the religious tendency is instinctive. The response is, however, coextensive with social groups, and the apparent purposes subserved at the lowest level are here stated as biological.

occasions upon which the impulse may manifest itself. This is not to say that the use of the religious tendency as a defense mechanism against the imperfections of the present does not receive great social sanction; it is to emphasize that much of the time, and in some groups most of the time, when the behavior appears, its biological purpose is combated.

Before extending our comments to include the sex instinct, we may best return and take up the thread of our argument as left on page 264 where it was stated that the second fundamental manner in which biological purposes are modified is the use of the instinct as a pleasure giver. It should be noted that with all instincts (not merely with that of sex) there is a pleasure and satisfaction in the experiencing of inherited muscular and glandular activity where the experiencer is free to turn his attention to the response as opposed to the stimulus. In the arousal of the instinct under conditions that realize or tend to realize the biological (and certain social) purposes of the response, the attention of the individual is definitely focused upon the stimulus which initiates and controls his behavior. Thus in a fire where the individual is in danger, it is not the emotional thrill which is in the focus of consciousness but the dangerous aspects of the situation. The bystanders, on the other hand, who have congregated, can enjoy the thrills of fear aroused by the fire because in the background of consciousness is the understanding that, so far as they are involved, it is all make-believe. It is beyond our intention to offer an explanation for this enjoyment of inherited forms of response under the conditions described; it is enough to indicate the fact and its implications for the modification of instinct. Within the limits of the apparently harmless, society sanctions the arousal of instincts for purposes of pleasure. Forms of art vie one with another in subtle stimulations of the instincts, while in the fringe of the beholder's consciousness the feeling of make-believe permits him to enjoy the resultant behavior. The individual confronts himself upon the stage and the screen with stimuli for all of the instincts—fear, anger, hunting, acquisitiveness, religion, sex, etc.—and then enjoys the result much as a child in play

will pretend the existence of hobgobblins in order to enjoy the thrill of fear, or wiggle a sore tooth or finger for the pleasure of the resultant pain.[1]

It so happens that the sex instinct is through heredity accompanied by a greater pleasure than pertains to the exercise of any other instinct, and it is therefore not unexpected that the history of the modifications of this instinct should be peculiar. In the animals below man, where there is no awareness of the biological end, the instinct functions solely for reproduction. No social purpose exists. The use of sex for pleasure, so far as I know, has its first beginnings among the monkeys, although here the probable absence of thought processes would count against its conscious use for that purpose. Moreover, among primitive men and even among peoples as advanced as the Central Australian natives, the biological purpose of reproduction is unknown (undoubtedly because of the great temporal interval between the activity of the instinct and the birth of the offspring), and yet there is sufficient development to insure the presence of definite social purposes. The result is that the sex instinct is recognized by society as a type of behavior whose purpose is the production of pleasure. Women are property, and the violation of chastity is the violation of a property right.

With the development of man to the point where the biological purpose of sex is understood, comes the possibility that society and the individual may definitely sanction the biological purpose. This they have done. Certain individuals and certain groups have maintained that the only conscious purpose to be sanctioned is the biological one; and yet in practice society at the present time sanctions the modification of this instinctive behavior by utilizing it in the ancient manner as a pleasure mechanism. This it does through emphasis upon birth control and the make-believe stimulation of the instinct on the stage and in certain phases of art in general.

[1] G. T. W. Patrick has made extensive use of the pleasurable aspects of instinctive activities as they appear in playful form. See his 'Psychology of Relaxation.' New York: 1916.

In the case of the food-getting instinct society and the individual do not at present combat the biological purpose, although they do relegate it to the background and satisfy it incidentally in many cases. In instances of perversion, however, the nutritive purpose has been definitely combated. Thus it is said that the Roman voluptuaries practised artificial vomiting in order that their banquets might proceed unhindered by the limited capacity of the individual. While our own banquets lack this interesting feature, nevertheless they are conducted for pleasure and not for the purposes of nutrition. Custom has from time immemorial recognized the effect on social solidarity of "breaking bread" together, utilizing the pleasurable aspects of feeding in the creation of consciousness of kind. This and similar uses of instinct to satisfy social rather than biological purposes is fundamental in understanding social phenomena.

IV

Summary.—The social significance of instinct cannot be brought out by analyses of the nature of specific forms of response, but must come largely from a consideration of the types of modification that instinctive forms of behavior undergo. These variations come fundamentally from the influence of habits and other forms of intelligent behavior. The present paper has elaborated the topic with reference to the following points: (1) Modifications of the structural elements, including (*a*) changes of the stimulus in its external or internal aspect, (*b*) changes of the somatic or of the visceral response, and (*c*) combinations of these in sublimated behavior; (2) the temporal position of the modification as it occurs before or after the initial appearance of the instinct; and (3) modifications of the biological purpose or adaptive value of the response.

THE NATURE OF THE RHYTHM EXPERIENCE

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Recent years have witnessed a marked decrease in the number of contributions to the experimental psychology of rhythm. Dunlap, writing in 1916, remarks, "It is a significant fact that experimental work on the perception of time and of rhythm has nearly ceased. One research on time, a statistical study of speech rhythm and a minor study on rhythm effects are all that have appeared in the last two years" (**7**, p. 206). With the exceptions of one or two studies, this statement is still applicable; in fact, the subject of time and rhythm has been dropped from the reviews in alternate years.

The reason for the discontinuance of scientific work in this field is not a knowledge of all the facts about rhythm, for such is not the case, but the lack of a working hypothesis for the nature of the rhythmic experience. The tentative bases which have existed up to this time have been given up, for the greater part, as the result of a tendency to eliminate time as an element of rhythm perception, and of the recognition of rhythm in others than the auditory field. Although these factors are the necessary result of each other, it is not until recently that they have been recognized, and that more than one aspect of the rhythm experience has become subject to analysis.

The earliest introspective and empirical studies,[1] and the modern theories of literary scholars, although characteris-

[1] Brücke, 'Die physiologischen Grundlagen der neuhochdeutschen Verskunst', 1871 (5).

Riemann, 'Katechismus der Musik,' 1888, p. 1 (36).

Lobe, 'Katechismus der Musik,' 25 Aufl., 1893, p. 4 (20).

Sully, 'The Human Mind,' Vol. 1, 1892, p. 271 (54).

Lanier, 'The Science of English Verse, '1880, p. 62 (19).

Gurney, 'The Power of Sound,' 1880, p. 127 (12).

tically vague,[1] have not seriously questioned the necessity of an absolute regularity in the recurrence of the objective elements. The view represented and assumed by them, has given way in the case of the former, under the influence of studies pursued under experimental conditions, until in 1903 MacDougall wrote: "There is properly no repetition of identical sequences in rhythm. Practically no rhythm to which the æsthetic subject gives expression, or which he apprehends in a series of stimulations, is constituted of the unvaried repetition of a single elementary form" (**22**, p. 319).

Under experimental conditions, rhythm was also removed from the field of objective stimulation,[2] to the field of subjective perception,[3] and finally to that of motor experience in time.[4] There has likewise been a tendency to limit the definition of rhythm greatly, from the cosmic recurrences of the universe (**3**, p. 146), to the field of human experience (**38**, p. 305), and here to the voluntary as opposed to the organic rhythms (**27**, p. 3).

Although most of the experiments with the voluntary

[1] Guest, 'A History of English Versification,' 1882, p. 1 (10).
Schipper, 'History of English Versification,' 1910, p. 3 (42).
Gummere, 'A Handbook of Poetics,' 1885, p. 134 (11).
Alden, 'An Introduction to Poetry,' 1909, p. 156 (1).
Mayor, 'Chapters on English Meter,' 1901, p. 4 (24).
Omond, 'A Study of Meter,' 1903, p. 2 (30).
Saintsbury, 'Historical Manual of English Prosody,' 1910, p. 291 (40).
Matthews, 'A Study of Versification,' 1911, p. 12 (23).

[2] Köstlin, 'Aesthetik,' 1869, p. 90 (17).
Riemann, 'Elemente der musikalischen Aesthetik,' 1900, p. 135 (37).
Cf. Wundt, 'Grundzüge der physiologischen Psychologie,' III., 1903, p. 158 (64).

[3] Squire, 'A Genetic Study of Rhythm,' A. J. Psy., XII., 1901, p. 586 (50).
Meumann, 'Untersuchungen zur Psychologie und Aesthetik des Rhythmus,' *Phil. Stud.*, X., 1894, pp. 272, 304 (25).

[4] Miner, 'Motor, Visual and Applied Rhythms,' Psy. Rev. Monog., V., 1903 (27).
MacDougall, R., 'The Relation of Auditory Rhythm to Nervous Discharge,' Psy. Rev., IX., 1902, p. 466 (21).
Stetson, 'A Motor Theory of Rhythm and Discrete Succession,' Psy. Rev., XII., 1905, p. 258 (52).
Ruckmich, 'The Rôle of Kinæsthesis in the Perception of Rhythm,' *A. J. Psy.*, XXIV., 1913, p. 305 (38).
Weld, 'An Experimental Study of Musical Enjoyment,' *A. J. Psy.*, XXIII., 1912, p. 298 (59).
Patterson, 'The Rhythm of Prose,' 1916 (31).

rhythms were in the auditory field because of the comparative ease of experimentation, it is a curious fact that writers of general accounts and text-books consider rhythm possible only in certain fields, whereas special investigators are confident that it is theoretically possible in every field. Thus Miner says: "There would be no reason *a priori* why a series of stimuli addressed to any one sense should not produce an experience of rhythm. I am quite confident that they would under proper circumstances; that rhythms of smell, taste, touch or vision are just as possible as rhythms of hearing" (**27**, p. 40). So Meumann, with temporal qualifications (**25**, p. 261); and according to Wundt, 'no series of impressions exists that cannot in some way be comprehended as rhythmic' (**64**, p. 62). Ruckmich asks whether a rhythm cannot be induced which shall be perceived principally in terms of those sensations that correspond directly to the nature of the stimuli given (**39**, p. 247); and Woodrow: "To produce an impression of rhythm, it is necessary to have a series of stimuli," enumerating some (**60**, p. 5); and Dunlap: "The facts seem to be that all sorts of sensations lend themselves to serial grouping" (**6**, p. 350).

Such pervasiveness of rhythm, however, is not understood by writers of general accounts and elementary texts. For them, rhythm is limited to definite fields of sensation, to the auditory, kinæsthetic, tactual and visual fields (**34**, p. 329); to the first three (**29**, p. 301); to the first two (**8**, p. 484); to the first (**18**, p. 389); and according to Titchener, there is rhythm in one and only one field, the kinæsthetic (**56**, p. 345). From this, it can be seen that the special investigators did not hesitate to generalize from their limited results, but that the general accounts were more cautious, and did not theorize. Among neither group, however, is there agreement. The result has been a condition chaotic in the extreme. In 1917 Ruckmich wrote: "Much experimentation has been done in the last two and a half decades on the general subject of rhythm. Theories have almost equalled these attempts in number, and difficulties have arisen out of all proportion to the facts discovered" (**39**, p. 326).

The Rhythm of Prose

In the latter part of 1916, however, appeared a new and important contribution to the rhythm of prose (**31**), in which it is stated unequivocally that a 'new standard' is established 'for passing judgment upon the rhythm of a sentence or paragraph' (p. 13). Although the title refers to the rhythm of prose, the book is concerned with the nature of rhythm in general.

From the example of syncopating rhythms of Indian music, where there are two levels of rhythmic stimulation, often in different times, as a melody in three-time against a tom-tom accompaniment in four-time (p. xx), it is suggested as the 'new standard,' that all rhythm is composed of two levels, an objective level and a subjective temporal measuring scale of 'unitary pulses,' 'elastic' in their nature (p. xx). "The 'boom! boom! boom!' of subjective time-units, such as rattle along in the consciousness of an aggressively rhythmic person, may be accelerated or retarded, within certain limits defined for each such individual, without destroying their value as a subjective foot-rule with which to correlate all experience" (p. 47).

The origin of the subjective time-unit may be the breathing rate. "Segments of breath-waves, each segment marked by a slight reinforcement in the flow of air, and measured, in turn, by so many concomitant heart-beats—when these are consciously felt—may easily register for us our mental seconds. It is only by such mental time-beats or 'unitary pulses' that we are able to make anything like accurate judgments of time. Suppressed articulation usually assists us in counting; our memory images record the number" (**32**, p. 259). Or the origin of the subjective time-unit may be the walking rate, and the memory of it, the basis of measuring. 'Perhaps, as each step is taken, the concomitant tension of some obscure muscle of the head occurs, which thus furnishes the means of repeating the walking-rate, without carrying the innervation as far as the legs' (**31**, p. 65).

Both levels, that of the objective stimulation, and that

of the subjective time-units are characterized by (1) acceleration and retarding (pp. 3, 47), (2) substitution of one long time-interval for several equivalent short ones, or vice versa (p. 3), and (3) syncopation, by which is meant the correlation of two sets of time-intervals, concomitant but not coincident (p. 4), as in the case of the Indian music mentioned above. "The impression which results from the combination in consciousness of the auditory (syllabic) sensations (including their effect upon attention) and the subjective time-units, may be compared to a melody and its accompaniment, with attention focussed, not upon the pitch relations so much as upon the relations of time and stress" (p. 69). The 'new standard' makes rhythm a temporal affair in that the subjective 'unitary pulses' measure time. "The ultimate basis of all rhythmic experience, however, is the same. To be clear-cut, it must rest upon a series of definite temporal units" (p. xxii).

Visual and Auditory Rhythm

Almost side by side with this study appeared a new contribution by Ruckmich in the field of visual rhythm (**39**, p. 231). Miner in 1903 found that "the experience of rhythm in the field of vision is identical in its essentials with that in the auditory field. Since the experience is novel, it is at first more vague than with sounds, but it becomes quite precise with practice" (**27**, p. 71). Koffka has concluded that "no essential difference between auditory and visual rhythm has shown itself," that 'series of visual imagery can be the sole associates of the experience of rhythm,' that 'for rhythmical experiences visual and auditory images are equivalent throughout' (**16**, pp. 96–97).

From these and other considerations of visual rhythm (**39**, p. 232f.), it seems clear that visual rhythm cannot be placed in a category different than that of the auditory. "All of the special studies which have been undertaken in this field are at one in pointing out that visual rhythm does not differ essentially from any other kind of rhythm" (p. 236). Nevertheless, Ruckmich has found that a purely visual

rhythm can be experienced as such (p. 247), that "it is possible to obtain rhythmical perceptions from stimuli that are visually presented and that differ objectively only in color quality. It is furthermore possible to obtain from such stimuli experiences of rhythm which are visual in their very essence, *i.e.*, in which no other processes play an important part" (p. 253).

Time and Rhythm

Although it may not appear so at first sight, there is a distinct conflict in the field of rhythm between the results of Patterson and Ruckmich. It is in the application of the 'new standard' to visual rhythm that difficulty arises. It is not clear the part that 'unitary pulses of subjective time' whose rate is 'about .7 sec.' (**31**, p. 67), would play in a rhythm induced in terms of stimuli that are not auditory, but visual. Visual rhythm can result from stimuli in terms of difference of color quality (**39**, p. 253), of difference of intensity of the members (**38**, p. 356), and what is of greatest importance, in terms of spatial structure,[1] as well as from the duration (**27**, p. 71), and temporal arrangement of the members (**16**, p. 104). Because of the nature of rhythmic stimulation, time is an element but it is ancillary to the rhythm. It is a prominent item in auditory rhythm, since, because of the nature of the end-organ, only series of discrete stimuli can be presented. Visual rhythm, likewise, is temporal in the aspect of serial stimulation, in that, since two stimuli cannot occupy the same place at once, one must follow the other in a time sequence.

While, therefore, it is true that recurrence is present in rhythm, and takes place in time, it does not follow that the perception of rhythm is due to a measurement of the recurrence by a 'subjective foot-rule.' Recurrence measured by time as an integral part of rhythm involves a confusion of one of the physical factors of rhythm with the nature of rhythm. According to Squire, 'Temporalness, in its connota-

[1] Meumann, *op. cit.*, p. 262 (**25**).
Koffa, *op. cit.*, p. 97 (**16**).
Miner, *op. cit.*, p. 43 (**27**).

tion of regular succession, is the basal principle of rhythm. This, however, is quite another thing than saying that the character of the grouping is dependent upon the time order" (**50**, p. 541). As Stetson points out: "The time judgment is much too vague to determine rhythmic intervals, and accurate judgments of time founded on rhythms are secondary and derived" (**51**, p. 258).

If absolute periodicity were indispensable in rhythm, a subjective temporal measuring scale would be necessary to ascertain whether rhythm were present or not. It has been shown, however, that regularity of recurrence is not characteristic of rhythm (**22**, p. 319). What function, then, can a temporal measuring scale have, unless to show that the recurrence is irregular? Yet regular recurrence is not of itself felt as unrhythmical. Nor can the time 'pulses' be a measuring scale as to whether the rhythm can be attended to. The action of attention is organic in its nature; in any case, its duration need not be subjectively measured. The only function a temporal measuring scale could have would be as a test for the presence of rhythm, and then only for irregular rhythm. An illustration may make the relation clear. A clock is a temporal measuring scale for the recurrence of night and day. But night and day are not dependent on the clock for their recurrence. Rhythm takes place in time, but time is not rhythm. According to Brown: "The regularity of the motor performance and the equivalence of the resulting feelings lead naturally to the introduction of the impression of temporal regularity; but that impression is really subsequent to the rhythm itself" (**4**, p. 44).

There is a further objection to a rhythm based on time measurement as determined by the 'new standard.' Patterson says that on the appearance of objective stimuli 'sufficient in number to suggest serial grouping' there is an adjustment of the 'pulses' by means of instinctive processes (**31**, p. 66). This would mean that a constant experience of rhythm would continue during the greater part of waking consciousness from presented stimuli, whether organized or not. This is not the case; the experience of rhythm is unique and unmistakable.

Finally, visual rhythm may take place in space. "The perception of rhythm may be aroused by visual impressions, whether by simple series of discrete stimuli, presented under laboratory conditions, or by the sight of rafters on a corridor ceiling, or of the recurring ornaments of a façade" (**56**, p. 345). Miner says, "There seems to be good reasons for believing that the perception of groups among repeated decorative figures, lines, etc., is a real rhythmical experience depending upon the repetition of a like accompaniment of strain sensations" (**27**, p. 43). Lastly Koffka found that visual rhythm may "easily assume, especially in the higher groups of beats, a spatial structure" (**16**, p. 97). "We will merely say this, that according to the result of this study, we can speak about rhythm in space just as in poetry or music. Aside from motor and auditory impressions and independent of them, purely visual impressions can serve as the sensory basis of group formations, and as a starting point of that inner activity which conditions accent and thereby rhythm. In the space arts, we find this realized in the repetition of an ornament to a considerable extent. The eye moves along and keeps meeting the same forms, and in this way, rhythm arises" (p. 109).

If visual rhythm differs from the auditory so as to have a different basis for its experience, it will be necessary to assume a heterogeneous nature for rhythm. Many factors point, however, to its homogeneity. First of these is the predominant presence in both of kinæsthesis (**39**, p. 249). Then there is the appearance, in both, of the secondary characteristics of rhythm, accentuation and grouping (p. 245). There are also similar illusions in visual rhythm, "apparently the same as those that have been noticed by other observers for sounds. They include the lengthening of the interval between groups, the intensive accent, and the shortening of the time between unaccented units in the three-group" (**27**, pp. 67–68). Ruckmich says, "Many of the phenomena which accompany other kinds of rhythm manifested themselves. Intervals were under- and over-estimated; attributes were subjectively assigned to the members; subjective rhyth-

mization occurred; and redistribution of the groups was common" (**39**, p. 254).

Kinæsthesis in Rhythm

Tentatively eliminating time as an integral part of the rhythm experience, we must return to the predominant elements which are characteristic of rhythm in general. Titchener, believing that rhythm was homogeneous in its nature, had come to the conclusion that there was one and only one rhythm, the ultimate basis of which was kinæsthetic. "The author was formerly disposed to attribute a separate rhythmical perception to hearing, but recent observation has convinced him of the existence of kinæsthetic sensations due to the contraction of the *tensor tympani* of the middle ear" (**56**, p. 345). As to rhythm aroused by visual impressions, "in the author's opinion, this rhythm is always kinæsthetic, based upon eye-movement, upon slight movements which tick off the successive impressions, or upon some other form of intermittent kinæsthesis" (p. 345).

The importance of the kinæsthetic factors had, however, been pointed out as early as in Bolton's work. "Each impression as it enters into consciousness tends to find expression in a muscular movement . . ." (**3**, p. 325). Even before, Gurney, than whom there were few keener observers, had called attention to them—"let the sounds become regular, and instantly the impulse comes to tap the hand or move the foot concurrently with them" (**12**, p. 128). They have been pointed out numerous times since. "By far the greater number of investigators and systematic writers on the subject of rhythm emphasize the primary importance of kinæsthesis and of motor response in rhythmical perceptions" (**38**, pp. 308–9).

Ruckmich, however, who says "in point not only of frequency of occurrence but of the importance of the part played, motor factors are almost indispensable items in the rhythmical consciousness" (**39**, pp. 246–7), states that after rhythm is initiated it may continue in the absence of kinæsthesis (**38**, pp. 342, 359). Bolton, however, says that if

movements were attempted to be restrained in one muscle they were likely to appear elsewhere (**3**, p. 234). Meyer (**26**, p. 37) and MacDougall (**21**, p. 466) found that the activity need not be visible in order to give feelings of movement, and Miner states that one subject who gave 'no response whatever to the metronome beat with her hand, head or body' showed considerable reflex response to the beats under hypnosis (**27**, p. 27f.). Lastly Weld found "when actual movements were inhibited one of three things usually occurred. In some cases the rhythmic effect was decreased; in others a tendency to movement appeared in some other part of the body; or, again a motor image or a visual image served as a substitute for the actual movement" (**59**, p. 265). We can therefore disregard Ruckmich's statement that rhythm may continue in the absence of kinæsthetic processes.

Mere kinæsthesis, however, as Titchener thought, is not sufficient of itself to explain rhythm. It limits rhythm to the kinæsthetic field as Patterson's theory limits it to the auditory field. Ruckmich has demonstrated a visual rhythm distinct from both. In addition, as Ruckmich has pointed out, the kinæsthetic factors although most prominent in the organs to which the stimuli are directed, are present in other fields as well as in the field of stimulation (**39**, p. 246), and the clearest part of the perception are the sensations and images corresponding to the stimuli given (p. 254). It is for this reason that he rejects the kinæsthetic basis of rhythm.

Since, however, the kinæsthetic factors are present in all rhythms, it may be well to inquire into their nature. Practically no work has been done on the nature and degree of stimulus as affecting the motor response in rhythm. The contributions which treated of the latter simply recorded they were present and made little or no attempt to localize and measure them as to comparative rate, intensity, quality, or to differentiate rates as manifested through different organs. Bolton suggested there must be different degrees of muscular activity depending on intensity of stimulus (**3**, p. 235), and Weld recorded larger muscular movements corresponding to the musical phrase (**59**, p. 266). Accurate work has, how-

ever, been done on the reflex response in another connection, and a grading of intensity found (**47**, p. 71). But the most important item and the basis of the rhythm experience is found in the following: "The rhythm of the reflex has practically the same frequence whether the reflex be excited strongly or feebly: thus, whether the amplitude of the contractions be great or small, they recur with practically the same frequence" (p. 122).

The Basis of Rhythm

A consideration of the essential elements in the various theories of rhythm formulated from Bolton to Patterson will show that a single hypothesis was in every case at the basis of their demonstrations. Preliminary experiments show that the motor response except for simple forms and certain rates of rhythmic stimulation, is independent of the rate of the stimulus. This has been widely recognized, but not acted upon.[1] It is clear that the reflex response in rhythm 'represents a relatively undifferentiated type of reaction' in response to stimulus (**21**, p. 474), but there are several elements of reflex response which have been overlooked when it was advanced as an explanation of rhythmic activity.

First of these is that in the reflex arc conduction, as shown by Schäfer, the rhythm of the discharge of the motor cell is totally different from that of the action induced in the afferent cell by stimulation (**41**, p. 613). In the nerve trunk conduction, on the other hand, there is a close correspondence between the rhythm of the stimulus and the rhythm of the end-effect. It was this latter correspondence which was erroneously made the basis of the motor theories of rhythm. But if, on the contrary, the motor reaction is a serial reflex response resulting from stimulation, the rate of response of the organ cannot depend on the rate of the stimulus given. This is the point of departure from all theories of rhythm heretofore.

[1] MacDougall, Psy. Rev., IX., p. 474 (21).

Stetson, Harv. Psy. Stud., I, 1903, p. 458; Psy. Rev. Monog., IV., 1903, p. 458 (51).

Sherrington, *op. cit.*, p. 71 (47).

It has long been recognized that each organ has a rate of response characteristic and constant for its particular activity. This rate has usually been called the 'natural rate.'[1] Scripture defines it as the rate in which one 'can perform the greatest number of movements with the least fatigue' (**44**, p. 181), and cites the 'route' step on long marches where each man chooses his own step (**45**, p. 107). Smith says that every one has his own rate which is variable within set limits (**48**, p. 82), and Patterson tries to correlate the different rates for various activities in the case of each individual (**31**, p. 148). As Weld found, 'we estimate tempo in terms of our momentary ability to make that motor response which seems to be most fitting for the particular composition which constitutes our stimulus' (**59**, p. 268), and according to Squire, the 'natural rate of the individual' is the basis of the pleasantness of rhythm (**50**, p. 588). Scripture, furthermore, has shown that the natural rate varies with practice, fatigue, time of day, general health, and external conditions of resistance (**46**, p. 528). The determining elements of this rate are certain structural and physiological factors.

Structural Factors

The rhythmical reflex, the response sometimes resulting from continuous stimuli, as, for instance, the scratch reflex, is subject to a certain periodicity in its functioning. It is not only at a frequency independent of the rate of stimulation, but does not change for various modes of excitation, for grouped succession of stimuli, or for variation in the intensity of the stimulus (**47**, p. 45f.). In other words, its period of vibration is constant (p. 122). The rhythmical reflex because of its periodicity may be said to be pendular in its character. Confirmatory of this is the periodic nature and constancy of the rate of response (p. 122), its tendency toward regularity regardless of the number of stimuli (**41**, p. 613), its independence of the tempo of the rhythm and the amplitude of

[1] Stevens, 'On the Time-sense,' *Mind*, XI., 1886, p. 393 f. (**53**).
Scripture, 'The Law of Rhythmic Movement,' *Science*, IV., n.s., 1896, p. 535 (**43**).
Scripture, 'The New Psychology,' 1899, p. 181 (**44**).

the movement (**47**, p. 122). In terms of the law of the pendulum, the amplitude of the reflex varies directly with the nature of the stimulus, but the period of vibration characteristic of the organ remains constant.

The periodicity of the rhythmical reflex is bound up with another aspect of reflex movement, *i.e.*, the refractory phase of muscular contraction, the period in which stimuli are without effect. In all reflexes which are rhythmic and not tonic in their nature, the refractory period is of importance for the maintenance of the movement. "The reflexes of which the refractory phase constitutes a prominent feature are those concerned with cyclic actions occurring in rhythmic series; such as the scratch-reflex, reflexes of swallowing and blinking, and probably the rhythmically recurring reflexes concerned in the stepping of the limbs" (p. 97).

It has been shown that the maintenance of the organic rhythms over long periods is due to the refractory phase of the muscular contraction, and that in voluntary movements, if a sufficient interval is allowed between the contractions, no fatigue is apparent (**13**, p. 49). A similar phenomenon is observable in the nerve cell (p. 139). There may be a relation between the pendulum rate of response and the refractory phase of the nerve cell. It is not, however, the rate of the nerve impulse which determines the rate of response, inasmuch as the different organs are subject to wide variations dependent on their structure. Furthermore, as Sherrington has shown, when one group of motor cells, that of the scratch reflex, is stimulated to produce a weak reflex, and another distinct group, that of the flexors of the hip, is then stimulated alternately with the first, although the second group can respond to a quicker rhythm than that of the first, nevertheless, the rhythm appears of greater amplitude, but unquickened and unaltered, without even a break or interference in it (**47**, p. 122).

In addition, because of the pendulum nature of the response, increase in the intensity of the stimulus does not affect the rate of the rhythm or the length of the refractory phase. "Increase of intensity of the reaction does not show

itself in increase in frequency of the rhythm of the reflex, or shows itself very slightly in that form, the refractory period being hardly curtailed at all. The increase reveals itself as greater amplitude of the individual beat of the rhythmic contraction. . . . The beats in response to a strong stimulus may have six times the amplitude of those evoked by a weak" (p. 71).

The motor response in rhythm, since it is also a reflex response, and operates through the same elements and external factors, would tend to show the same characteristic of regularity as the rhythmical reflex. The rhythmical reflex may be identified with the reflex response, with the difference between them that the latter is simpler and uncoördinated in its character; for many forms of stimulation, as some musical stimulation, are continuous, yet give rise to a reflex response, while, on the other hand, the rhythmical reflex is not affected by grouped succession of stimuli (p. 48f.).

Whether or not identical, the same periodicity has been found to govern the reflex response. As in the case of the rhythmical reflex, the basis of the rate and its regularity is, to a large degree, the result of the mechanical factors involved. Among these, the most important is the length of the member and of its parts; as in walking, the rate of time varies inversely with the length of the limb (**41**, p. 270). Wundt speaks of the principle of the isochronisms of like amplitudes of the limbs, and defines rhythmical movements as ones in which the voluntary energy of the muscles is operative only so far as is required to set the limbs oscillating in their joints and to maintain the movement (**63**, p. 174f.). Miner recognized the importance of this factor—"it must be some structural arrangement of our body by which a series of like impressions diffusing to the muscles produces not a separate wave for each impulse, but a longer wave corresponding to a group of impulses" (**27**, p. 34).

The structural element, here likewise, results in a pendulum movement. Stetson has described the mechanism which gives rise to the rate of muscular response as a contraction-relaxation process working between the positive and negative

muscle-sets of the limb (**52**, p. 268f.). As in the case of the pendulum, the limb is carried past the point where the generating force is lost by momentum alone (p. 262). The force in the case of the limb is the contraction of the muscles involved. "Thus the limb is *thrown* back and forth, and caught in turn at the limits of its movement by the positive muscle-sets" (p. 262).

It seems clear from the governing effect of the structural factors and their relation to the refractory phase of contraction, that the periodic reflex response, like the rhythmical reflex, is not coördinated with the objective stimulation, but is dependent on the pendulum rate of the member of response. This is further indicated by the periodicity and constancy of its character (p. 263–4), its independence of the rate of stimulation and of the variation in the number of stimuli (**27**, pp. 36–37). Stetson found: "An obstacle against which the limb strikes does not affect the character of the movement; at the end of the normal interval the negative muscle-set contracts and withdraws the limb, as if the limb had shot to the end of the course unimpeded" (**52**, pp. 263–4).

The fact that the basis of rhythm is motor response, and that this motor response is periodic in its nature, and similar to the pendulum in its movement, leads to the thesis that rhythm may be defined as the *experience arising from the periodic, pendular, reflex response of characteristic organs to objective stimulation.*

This definition has been the foundation of so many theories and systems that it is difficult to see why it has not been formulated before. Each of the various theories which were scientific in their nature, recognized one or more of the elements, but were inadequate because they made the one element unduly prominent because of the type of apparatus employed, the sole basis. Bolton recognized that regular muscular response resulted from stimulation, but because of the key-board arrangement which he used, thought it was to every stimulus (**3**, p. 235). Miner saw this was not the case, that these movements were 'something more than one respnose to each stimulus' (**27**, p. 30), but because he found

that a single response took place for a group of stimuli in the case of the metronome, assumed therefore that the muscular response was the basis of grouping (p. 12). Both are correct in what they saw, but neither explanation is the basis of rhythm. Stetson found that the duration of the muscular contraction was 'strikingly uniform,' and 'independent of either the tempo of the rhythm or the length of the stroke' (**52**, p. 261), that an obstacle against which the limb strikes does not change the normal interval or the character of the movement (p. 263), but he explains this on the ground of experience. "It is experience alone which teaches us to guide the ballistic stroke" (p. 263). To Patterson, 'syncopation' was emphasized; it is the basis of his rhythm—syncopation between the objective stimulation and the 'unitary pulses of subjective time' (**31**, pp. 4, 67).

Each of these contains an element of the nature of rhythm, but each is a theory of the apparatus. Bolton used a keyboard arrangement; Miner used a metronome; Stetson used a baton; Patterson saw the Indians dance; and all made the peculiarities which were emphasized, the basis of a system. Only MacDougall recognized that the muscular response was independent of the rate of stimulation, and yet not limited to one organism (**21**, pp. 466, 474), but he thought the recurrent stimulation exerted an inhibitive influence 'if its periodic phases are in opposition to those of the natural rhythm of the sensori-motor process itself' (p. 474). He also believed that in addition to the reflex response there was a physiological rhythm 'in the functioning of the central nervous system,'—'functional facilitation and reflex motor discharge, I conceive to be represented in the conditions which support the impression of rhythm' (p. 466). The first factor, the possibility of lack of coincidence of stimulus and response, was also recognized by Stetson: "What happens when a sound occurs out of place, early in the phase of relaxation, or just before or just after the climax of the contraction phase? Does it make it impossible to establish the coördination, or destroy it if already established?" (**51**, p. 458).

It is evident that at certain rates there may be two

opposing tendencies, that of the periodic, pendular response, and that of the rate of stimulation. Weld found that when music seemed too fast, it was 'too fast for the particular motor reaction which seemed most natural to the observer' (**59**, p. 267). When not of identical occurrence, but when within favorable limits, the response may tend to approximate the rate of stimulation. Stevens found that intervals of a subject who beat time to a metronome, and continued after the metronome had stopped, agreed only when a particular interval was used (**53**, p. 401). Even here, however, there may be a gradual divergence, which, when it becomes appreciable, requires an adjustment. "The introduction from time to time of a single extra tap, with the effect of transposing the relations of the motor accompaniment to the phases of the metronome, has been here interpreted as arising from a periodically recurring adjustment of the reaction process to the auditory series which it accompanies, and from which it has gradually diverged" (**22**, p. 338).

When there is regular presentation and regular reflex response, if a favorable organ is available, there will result a correlation between the response and a certain number of stimuli. But the relation may not always be an essential one, and even Miner, who has made this relation the basis of his whole system, says, 'the length of the group does not increase proportionately to the number of elements in it,' and farther on, 'we know that the same individual varies greatly in the length of the group he chooses' (**27**, pp. 36–37).

Due to the many forms of reflex response, there is no one unit 'to correlate all experience,' no one basic rate of measuring as Patterson has ascribed to the walking rate (**31**, p. 64). Miner recognized that it is misleading to claim there is a 'standard length of group or that the normal group depends on respiration, fatigue or any particular physiological rhythm as determining its natural length' (**27**, p. 39). The walking rate which Patterson uses as the basic rate for the whole rhythmic experience, is only one manifestation of the motor response and is dependent on the pendulum rate resulting from the factors involved in walking, just as the nodding rate is dependent on the factors involved in moving the head.

There is still another characteristic of reflex action which influences rhythm, the after-discharge. It is usually a tetanic contraction after the cessation of stimuli, and is affected by increase in the number of stimuli and increase in the intensity of the stimulus (**47**, pp. 28, 30). The after-discharge throws some light on the pause in verse. In the rhythmical unit in verse, it has been found that the final element has greater duration and intensity than the other elements. Thus Snell records that the word or syllable in a verse immediately preceding a pause is marked by greater duration and probably intensity (**49**, pp. 39, 47). The discharge of an unusually strong impulse leaves the nerve cell exhausted and a certain time to be recharged is required. So Stetson found that in lyric verse, the verse pause was from one fourth to one third longer than the foot pause (**51**, p. 443), and that since the end of the verse is the natural climactic position, rhyme was also preferable at the close (p. 429). Snell found that in lyric verse, the end-pause is twice as long as the internal pause. In some verse rhythm, the rhythmic unit is also dependent on the summation of effect, when there is not a complete relaxation after each response (*cf. infra*).

The Initiation of Rhythm

In the initiation of rhythm, according to Patterson there is an adjustment by means of instinctive processes of the elastic unitary pulses and the objective auditory stimuli, sufficient in number to suggest serial grouping (**31**, p. 66). Practically all other investigators consider the kinæsthetic processes the basis of the initiation of rhythm. Ruckmich thought the kinæsthetic processes were references for its interpretation when it is first heard (**38**, p. 351), and that in the initiation of a difficult rhythm they may be even the most prominent item (**39**, p. 247).

The initiation of rhythm it is suggested presents the following phenomenon. Unless there is a preconceived pattern of response, stimuli not strong enough of themselves to evoke a reflex response may, when repeated, result in a summation of stimuli and produce contraction. This continues

till the pendulum rate is organized, and the adaption to the refractory phase established. The organizations of most poetic meters is on a basis of the reflex pattern. If, however, irregular stimulation in the absence of a pattern of response is presented, confusion results at first, and until the adjustment is made; or if it is never made, or if the recurrent stimuli are too frequent and intense, the rhythm is never initiated.

Ruckmich states: "Should the rhythm be more than moderately difficult, and should it, therefore, not become definitely fixed, or should the mental set of *O* be such that he cannot make the rhythm 'fit in,' the pleasant affection may never be reported, and strain sensations may continue in a vague degree to the end. . . . Then, ordinarily, sensations of strain gradually die away, attention drops in level, kinæsthesis grows less intensive and extensive, and finally vanishes completely or becomes irrelevant to the rhythm. The rhythm is heard merely in terms of auditory perceptions" (**38**, p. 342). Scripture found that in the beginning of an experiment on a rhythm with a new period, the subject is quite at a loss for a few beats and can tap only spasmodically until he obtains a 'subjective judgment' of the period (**46**, pp. 527–8). Smith says, "It is doubtful if a rhythm is really perceived before a certain degree of facility or skill in the movement is attained" (**48**, p. 289).

The reflex pattern may result through the pendulum rate asserting itself, or through the establishment of the latter by presented schedules in its terms. Patterson found that on the first hearing a large number of observers found all the records which he used elusive and more or less irregular (**31**, p. 2). When organization through schedules was presented, various degrees of satisfaction were obtained (p. 64). Even when there is a schedule, however, confusion may result when there is a maladjustment of the pattern to the stimulation, as in an attempt to read anapæstic meter when the motor response is adjusted to iambic. Wallin found that schematic arrangement was an aid to such an extent as to differentiate prose and poetry (**57**, p. 64).

The case of involuntary movement is interesting in this

connection. Miyaki found that "arhythmic movements have a constant tendency to become rhythmic, notwithstanding the voluntary effort of the subject to execute the movements at irregular intervals. The subjects of the experiments invariably agreed in confessing that the arhythmic tapping required strenuous effort and that the performance was very fatiguing" (**28**, p. 4). Voluntary irregular movement necessitates a disturbance in the refractory phase involved and the pendular aspect of movement.

Syncopation

The phenomenon of syncopation to which Patterson has drawn experimental attention, "in itself, involves a complex of mental processes. The most essential part of the phenomenon seems to be that we keep our impression of a series of subjective time-intervals, regular, accelerating or retarding, but find a pleasure in marking the beats objectively, either by different forms of motion, such as foot-taps alternating with hand-taps, or by what appears at first as omission of objective marking for certain beats. As a matter of fact, this is usually nothing but the interpolation of some concealed form of motor reaction such as eye, throat, tongue, or breath movement, which alternates with a more visible movement, such as nodding or tapping or dancing" (**31**, p. 4).

Stetson has described it in much the same terms. "Along with this precision of all the movements comes a tendency to beat a new rhythm. This accompanying rhythm is simpler and broader in character; it is a kind of long swell on which the speech movements ripple. This second rhythm may express itself in a new movement of hand, head, foot or body; when it has become more conscious, as in patting time to a dance or chant, it develops complicated forms, and a third rhythm may appear beside it, to mark the main stresses of the two processes. The negro patting time for a dance beats the third fundamental rhythm with his foot, while his hands pat an elaborate second rhythm to the primary rhythm of the dancers. . . . This regulation of the movement by the coincidence of several rhythms is the cause of the striking regularity of the temporal relations" (**51**, pp. 465–6).

In Patterson's definition (**31**, p. 4), syncopation is apparently manifested by the performer of the rhythm. Syncopation is used by Patterson in three senses, (1) as any full motor response (p. xix), (2) motor response in the performer of the rhythm (p. 4), (3) a correlation of the 'unitary pulses' and objective stimulation in the observer (p. 91). This analysis has shown that while there is coexistence, there is not necessarily correlation and rarely coincidence of the objective stimulation and the reflex response. Syncopation in the third sense exists, but it is limited to a comparatively small field of rhythm.

Full motor response is not so evident in modern rhythm. As Patterson says, "Modern sophistication has inhibited many native instincts, and the mere fact that our conventional dignity usually forbids us to sway our bodies or to tap our feet when we hear effective music, has deprived us of unsuspected pleasures" (p. xix). Patterson concludes: "What is left, then, but to conclude that the sentence which has in its structure the possibility of a maximum of rhythm must be capable of evoking in us a maximum of motor response? To test it, therefore, we must tap to it, nod to it, walk to it, sway to it, chop wood to it, if necessary. . . . If it is easy for us to nod or tap, or, for that matter, hoe potatoes to these salient 'drum-songs' . . . the first degree of rhythmic excellence is obtained" (p. 15).

The contortions of the polar bear which Patterson has called 'prose' merely present syncopation of the muscular responses of various organs due to the pendulum rates of the organs. They are not, however, 'harmoniously but intricately regulated by the incessant unitary "flap! flap! flap!" of those great white feet' (**32**, p. 261). Each is as independent in its own sphere as the walking movement is in its sphere. The large body of literature on rhythm, then, is not invalidated by the 'new standard.' On the contrary, it is enriched by the hitherto experimentally unrecognized field of syncopation.

The Factors of Attention

Although rhythm is intimately bound up with attention, the unsatisfactory state of knowledge about the latter prevents a wholly satisfactory correlation of the two. Ruckmich says that during the rhythm experience attention is at a high level (**38**, p. 342), and he believes that there is a typical rhythmical consciousness (p. 341). Bolton ascribes grouping and accentuation to a 'sequence of acts of attention' (**3**, p. 211), and with this position there is substantial agreement. Squire says: "One group corresponds to one pulse of attention, and the regularity of the subjective rhythm is due to the regularity with which the pulses of attention succeed one another" (**50**, p. 575). MacDougall posits a kinæsthetic level due to changes in attention, 'those elements which are emphasized being likewise more clearly attended to' (**21**, p. 468). Meumann says that rhythm may be regarded as an unlike energy division of the attention, an alternation of attending and not attending (**25**, p. 304). Arps and Klemm found that the greatest degree of attention occurs at the accented sound and the least at the second unaccented sound (**2**, p. 518f.). Rhythm was at one time thought to be solely a matter of attention (**35**, p. 164; *Cf.* **34**, p. 330).

In repeated stimulation resulting in rhythm, it is clear that there are two kinds of presentation, regular and irregular. There is no essential difference between them from the point of view of rhythm, other than that of degree. There are, however, two classes of stimulation which are different in their nature, that objectively accented and possibly grouped, and that undifferentiated. An example of the first class is most poetry or music; an example of the second class is the ticking of the metronome or the puffs of a locomotive. Neither grouping nor accent, however, are necessarily a part either of the objective stimulation or of the periodic response.[1] Neither are present in organic rhythm nor at certain rates in presented rhythm. It is evident that

[1] *Cf.* Patterson, *op. cit.*, p. 4 (31).
Squire, *op. cit.*, p. 540 (50).
Wallin, 'Experimental Studies of Rhythm and Time,' Psy. Rev., XIX., 1912, p. 297 (58).

they do not cause nor are they the result of the periodic response. Grouping and accentuation, it is suggested, are the result of the organic rhythm to which attention itself is subject (V. **33**, p. 70). Wundt in speaking of the periodic rise and fall of attention says it may become regular in its periods when there are special considerations favoring rhythmical succession (**63**, p. 255). Titchener says: "As for the effect of the anticipatory image, it is clear that, the more nearly the excitation correlated with the given stimulus coincides with a psychophysical excitation already in progress, the more easily will it make its way within the nervous system and the more dominant will it become" (**55**, p. 205).

The results of attention also appear with undifferentiated stimulation and give rise to accentuation and grouping. It is in the case of undifferentiated stimulation that the verification of the suggestion must be found. "It is the fact of periodical differentiation, not its particular direction, which is important. Further, as we know, when such types of variation are wholly absent in the series, certain elements may receive periodical accentuation in dependence on phases of the attention process itself, and a subjective but perfectly real and adequate rhythm arise" (**22**, p. 320).

The operation of rhythm can be thought of as, on one part, objective stimulation, regular or irregular; on the other part, regular serial reflex response. Bridging the two is attention, which acts in its own way. Rhythm arises from the reflex response; accent and grouping are the result of attention.

Supplementary evidence that this is the case is furnished by the illusions of the durations of the undifferentiated member and its contiguous intervals. "The effect of both intensity and duration in rhythm may be generalized as follows. If every second or third sound is made more intense or is made shorter, the effect on grouping is the same as if the interval immediately preceding that sound were increased relative to the other intervals. The effect of the more intense sound, when all the sounds are of equal duration, or of the shorter sound when all the sounds are of equal intensity, is a

relative overestimation of the interval preceding the more intense or the shorter sound" (**60**, p. 66).

Ruckmich, following Miner, lays great stress on kinæsthesis as the basis of grouping and accentuation. He says, "Three points are certainly clear: (1) the kinæsthetic complex changes for accent and non-accent, (2) kinæsthesis on the accent is more intensive and is felt as strain or tension, while kinæsthesis on the non-accent is less intensive and is felt as relaxation, and (3) kinæsthesis, prominent as it is, may be temporarily or entirely replaced by visual or auditory complexes" (**38**, p. 336). "To the writer the group appears to be a complex of perceptions organized in terms of imaginal and kinæsthetic processes on the basis of affectively toned organic processes" (**39**, p. 254). MacDougall, however, places the kinæsthesis of attention on a different level than that of the motor accompaniment although he says it is concomitant with the sensory series (**21**, p. 467). The question arises whether this particular kinæsthesis of strain or tension is not of this nature and dependent on attention (*cf.* **3**, p. 211).

Poetic Rhythm

A word may here be said on the rhythm of poetry. The rhythmic experience arising from poetry is more satisfactory than that of prose although Patterson would consider it of an inferior order. "The aggressive 'timer,' of course, gets his keenest delight from prose in the fact that he feels no trammels" (**31**, p. 84; *cf.* **21**, p. 478). That this is not the verdict of experience is shown by the fact that all peoples in all times have chosen poetry as a vehicle to express their most satisfactory experiences. In poetic rhythm, there is the possibility of greater correlation between the regularity of the periodic response and of the occurrence of the objective stimuli. This does not mean, however, that they are coincident. Patterson says that poetry is the result of coincidence of the unitary pulses and the accented syllables (**31**, p. 91). Considering the unitary pulses as equivalent to one form of response, this may be true for a limited body of poetry, but it would be at the sacrifice of attention and

interest. According to Weld, movement is not unison with the *Takt*, but is in accordance with the musical phrase (**59**, p. 266).

At the same time the methods of the 'stresser' and all schematic classical systems of scansion which Patterson so greatly condemns (**31**, p. 83), have been of use and still are in classifying certain forms of poetry. The unfortunate result of their use was to render difficult of analysis the nature of poetries, in which the motor response is not so nearly correlated with the objective stimulation. For this reason, the nature of biblical meter was obscured for nearly twenty centuries although scholars had worked on it steadily during that time. Its nature recently indicated (**14**, p. 20), shows as close an approximation to the motor rhythm of other poetries, but not through stereotyped metric forms. The motor response arises in connection with the normal unit for recitative. Its basis is the 'word-foot,' so that there is an identification between the word and the unit of response (p. 41). This is possible through the similar lengths of the words (p. 41). The rhythmic unit corresponding to the verse, however, is of definite and invariable lengths, consisting of three units and, in a certain form of poetry, of two units (p. 44). Furthermore, owing to the intense form of the poetry, there was not a relaxation after each response, but a simple and clear case of summation of effects resulted, which gave rise to the parallelistic structure (**15**, p. 114).

In the adult reading of the modern verse, the characteristic reflex response seems also to be in relation to the point of maximum emphasis rather than in any indispensable relation to the uniform metrical foot. It is dependent on the form of reflex response. Brown found that the verse in English poetry seems to be divided into short phrases which are fairly uniform in their length while the feet are not (**4**, p. 51).

Elements of the Definition of Rhythm

(*a*) Affective Tone

Whether affective tone should be included in the definition of rhythm has been put in issue between the extremes of Smith

who says that rhythm no longer exists when affective tone becomes unpleasant (**48**, p. 287), to Squire who says that feeling is not essential to the perception of rhythm (**50**, p. 587). There are many intermediate views, and some that cannot be placed at all. Wundt defines rhythm as an emotion arising from the feelings of expectation and satisfaction (**61**, p. 311; **63**, p. 200), and says the pleasantness of rhythm depends on the repetition of feelings of tension and the contrast between feelings of tension and relaxation (**64**, p. 158f.). Meumann says that the affective tone of rhythm depends on the mood of a given time (**25**, p. 266), and according to Smith, although she gives no citation, defines rhythm as an emotion discharging itself in ordered movements (**48**, p. 292). Ebhardt places the main stress on affective tone and makes it the *sine qua non* of rhythm (**9**, p. 127). Ruckmich says rhythm may change from slight unpleasantness before it is grasped, through pleasantness when it is thoroughly perceived, to unpleasantness when it continues without change (**38**, p. 359).

Throughout these theories there runs an unconscious distinction between affective tone as a result of the rhythmic experience and affective tone as an element of it. If the latter is true, then the statement that 'there is no poor rhythm' (**48**, p. 292) is correct. The weight of the evidence, however, is against this. Rhythm may be unpleasant; at times it may be 'dreadful' (**3**, p. 221; **48**, p. 285).

Affective tone is the result of rhythm, but since rhythm is a continuing phenomenon, the affective tone aroused by the feelings of repeated, perfected movement, has been thought to be the cause of the rhythm coming. Squire says: "The affective tone increases in proportion as the summation of excitation increases, till a state bordering on ecstasy may be reached. Ecstasy, when it follows upon rhythmical stimulation, is due to a spreading of the excitations to a greater and greater number of centers, till the body and the whole of consciousness are set in co-vibration" (**50**, p. 588).

(*b*) Complexity

Every investigator whether or not he includes affective tone is his definition of rhythm is very certain and unequivocal

as to its complexity. This is practically the only point that all are agreed upon. Thus Meumann says: "The error must be emphatically combated, that on defining any one of these elements, even of the so-called equality of the beats, we have defined the nature of the rhythm," but enumerates the various factors which are necessary for the experience of rhythm. "In this manner, in the rhythmical impression we shall have to seek for the elements of time, accent and pitch. By the side of these there must be distinguished a number of higher intellectual factors, whose operations we must seek in the inner comprehension, in the additions of subjective accent, in the strain and relaxing of the attention, the relating of the rhythmical groups to one another, their perception as repetition of the preceding and preparation for the following impressions" (**25**, pp. 305–6). So Wundt (**62**, pt. 2, I, p. 376f.); and Ruckmich says, ". . . the rhythmical perception is an exceedingly complex affair. . . . The grouping effect of a rhythm in any case may depend on visual patterns, on auditory imagery, on organic complexes, on changes of clearness, on alterations of temporal arrangements, on verbal ideas, on motor responses, and on many similar items" (**39**, p. 247).

Likewise Patterson is careful to point out this item of the experience. "Rhythmic experience may thus be roughly described as a complex of perception, emotion, and sensation, with all three elements subjected to the moulding processes of attention, both voluntary and involuntary" (**31**, p. 91). There is ample complexity here, yet elsewhere he says, "The final impression of rhythm derived from a sentence is, to a large extent, a fusion of elements, in which actual pitch, tone-color, thought, mood, capricious or logical attention, etc., enter as factors in addition to duration, stress, and the dim elements of pitch, actual or purely subjective, implicated in the drum-beat tune" (p. 70).

Summary

Rhythm is the experience arising from the periodic, pendular, reflex response of characteristic organs to objective stimulation. There are four elements in the impression of

rhythm, the perception of the objective stimulation, the experience of the periodic reflex response, accentuation and grouping resulting from attention, and the affective tone arising from repetition of movement.

The pendulum rate is the rate at which an organ vibrates in the absence of voluntary factors, and is the result of the length of attachment of a member, and of the refractory phase of the muscles involved.

The reflex response is the result of, but independent of the stimulation, and depends on the pendulum rate of the member responding. Because of the periodic nature of the reflex response, regularity was read into the objective stimulation, and it was thought that the latter must be chronometrically proportionate. This belief gave rise to elaborate and sometimes artificial systems of meter, and prosody was erected into a science.

The objective stimulation has one prerequisite, that the discrete stimuli recur so as to give rise to a serial response. With this qualification, the stimulation may be regular or irregular, accented or unaccented, grouped or ungrouped.

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A NEW POINT OF VIEW IN THE INTERPRETATION OF THRESHOLD MEASUREMENTS IN PSYCHOPHYSICS

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I. Introduction

I propose in this paper to examine some of the ideas underlying the interpretations hitherto given of threshold measurements, and in particular (*a*) the measure used in comparing the sensitivity of one individual with that of another, (*b*) the measure of sensitivity used in testing Weber's Law, (*c*) the origin of this law, whether it be psychological or physiological, (*d*) the idea of a psychometric function, and (*e*) the notion of the probability of a judgment. These points cannot be treated separately, but must be considered in conjunction with one another. The ideas which I wish to express have their origin, however, chiefly in an extension of the last-mentioned point.

II. The Difference Threshold

To fix ideas, I shall discuss difference thresholds only, leaving the question of absolute thresholds aside. Further, I shall use the case of experiments on lifted weights, by the Method of Right and Wrong Cases.[1] In this form of experiment, comparison weights are contrasted frequently, one by one, by lifting them in a specified way, with a standard weight, and on each is expressed a judgment *lighter*, *undecided*, or *heavier*. When a sufficient number of judgments have been collected, the three categories are found to occur with varying frequency with different comparison weights, and curves similar to those shown in the accompanying diagram can be constructed.[2]

[1] Otherwise termed the Method of Constant Stimuli, and the Methode der drei Hauptfälle.

[2] For fuller details of the determination of this and other thresholds, and for references to experimental memoirs, the reader may consult G. T. Fechner, Elemente

In this diagram the points marked on the x-axis represent the comparison weights. The height AB represents unity, and the three curves give the proportional frequency of answers *lighter*, *undecided and heavier* respectively, the *undecided* curve being a bell-shaped curve, and the other two being what Galton termed *ogives*.[1] The difference threshold

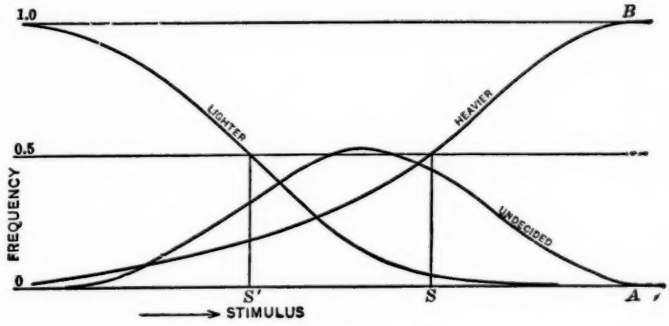

FIG. 1

is then decided by the positions of the points S and S' where the *lighter* and *heavier* curves cross the halfway line.[2] The distance $(S - S')/2$ or some closely similar quantity is what is called the difference threshold, and this quantity is commonly used in comparing the sensitivity of different subjects. The smaller $(S - S')$, the more sensitive the subject is said to be.

This distance however depends entirely on the subject's

der Psychophysik, 1869; G. E. Mueller, Die Gesichtspunkte und die Thatsachen der psychophysischen Methodik, Wiesbaden, 1904; W. Wirth, Psychophysik, Leipzig, 1912; and F. M. Urban, The Application of Statistical Methods to the Problems of Psychophysics, Philadelphia, 1908.

[1] The actual experiments of course do not give curves but only points through or among which the curves are then drawn smoothly, either by hand, by a flexible ruler, or by assuming mathematical equations for the curves. In the latter case if the equations contain sufficient constants, the curves can be made to go exactly through the points; otherwise the best fitting curves are drawn by some method such as the method of least squares or the method of moments.

[2] These points on an ogive are analogous to the medians of bell curves. Some experimenters, instead of calculating these medians, calculate points analogous to means. These differ slightly from S and S' but these differences have no bearing on our present argument. Questions of space and time errors also arise.

readiness to give the answer *undecided*. It measures therefore rather a moral characteristic than a physical sensitivity. It is a question of quickness of decision on small evidence just as much as a question of difference of amount of evidence. If persons *A* and *B* differ widely in the number of *undecided* answers which they give, it may just as well be their habits of forming decisions which differ, and not their power of actually discriminating the weights. The moral character of the measure $S - S'$ is above all seen from the fact that any subject who wishes may reduce it to zero, whatever may be his actual sensitivity, simply by determining that he will never give an answer *undecided*. Difference thresholds therefore are unsuitable for comparing the sensitivity of different subjects.

III. The Interquartile Range of the Point of Subjective Equality

There is however another measure which has been used for this purpose. This can be most conveniently described by considering first a case in which a subject gives no *undecided* answers. In such a case the central curve of the former diagram, that is the bell-shaped curve, disappears, and only the two ogives are left, as in the accompanying Fig. 2. The thresholds *S* and *S'* have come together and on the previous plan the subject's sensitivity would be considered

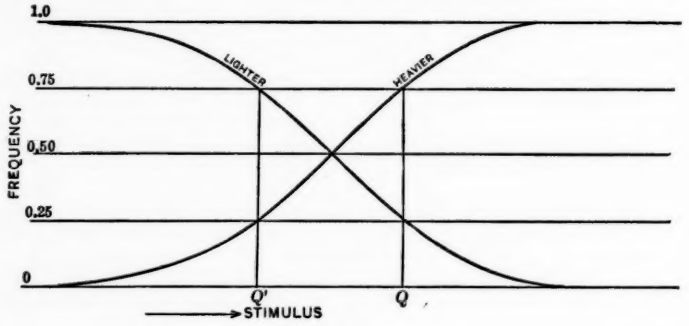

Fig. 2

infinite, and all subjects giving no *undecided* answers would be given the same infinite sensitivity, whereas clearly the subject's sensitivity is connected with the rapidity with which the curves pass from zero to unity or vice versa, and two subjects may differ very much in this respect even although they may both give no *undecided* answers. Under these circumstances a measure which has been used is the distance $Q - Q'$ which is sufficiently explained by the diagram. This measure (though in another guise) was used by Fechner also for the cases where *undecided* answers were given. In such cases he reduced the three curves to two by sharing the *undecided* answers equally between *heavier and lighter.* This measure has the advantage that the subject cannot increase his apparent sensitivity at will, as was the case with the threshold measure. $Q - Q'$ is the interquartile range of a hypothetical point of subjective equality. It and the difference threshold measure distinctly different things and subjects placed in order of merit by the one will be found in a different order when graded by the other. The measure $Q - Q'$ is more physiological than the threshold measure.

IV. Weber's Law

Although these two measures, the difference threshold and the interquartile range of the point of equality, measure different things and give quite different results when we are comparing separate subjects, yet in one and the same subject each of them obeys Weber's Law in so far as that law is obeyed by any measure. It would appear that some light might be thrown on the question whether Weber's Law is physiological or psychological in its origin by a comparison of the accuracy with which these respective measures obey that law, although such a comparison would not be crucial. If, however, the difference threshold were found to obey Weber's Law more exactly than does the probable error of equality, then I should consider this distinctly in favor of a psychological explanation of the law. But I should myself anticipate the other measure to obey the law more exactly, which, although by no means proving a physiological explanation to be correct, would nevertheless point in that direction.

V. Psychometric Functions

Turning now temporarily aside from the considerations which have occupied us up to this point, let us consider some questions arising out of what is known as the search for the 'psychometric function.' These functions are the mathematical equations which best fit the bell-curves and ogives into which psychometric data fall. They are clearly error functions of some sort or other, and there is no particular advantage in calling them psychometric functions. For our purpose here it is sufficient to consider the possibility of the "psychometric function" being the normal curve of error, and to leave the elaborations necessary when more complicated functions are used. What is here said about the normal curve is typical and true of other suggested functions such as Professor Pearson's types.

Consider Fig. 1. The suggestion has been made by many that the extreme curves, the ogives, are integrals of the normal curve of error. The bell-curve in the center is deduced by these writers by first forming the outer curves and then subtracting their sum from unity at each point. All the usual arguments, however, which support the view that the outer curves are integral normal curves would lead one to expect, when applied to the central curve, that it is a normal curve as it stands. But this is impossible. Two such normal ogives added together and subtracted from unity, ordinate by ordinate, do not give a normal bell curve.

VI. Extension of the Notion of the Probability of a Judgment

This difficulty can I think be overcome if we recognize the fact that these curves are not each of them complete error functions, but represent *one* error function divided into three parts (the division itself however being no doubt in turn subject to an error distribution).

This involves an extension of the idea of the probability of a judgment. In its simple form this idea compares the giving of a judgment *heavier*, *undecided*, or *lighter*, with drawing a ball from an urn containing say red, white, and blue

balls, and ascertaining its color. For each stimulus the urn is supposed to contain different proportions of the colored balls.

In place of this I suggest the following. For each stimulus imagine an urn containing an infinite number of balls divided between black and white in a proportion varying in some way with the stimulus. A judgment is to be compared with taking not one but a handful of balls from the urn, and the kind of judgment is to depend on the proportion of black balls in the handful.

VII. The Resulting Curves

To clear our ideas let us take a concrete case with small numbers. Suppose an urn contains seven tenths black and three tenths white balls, and that a judgment corresponds to drawing four. The possibilities that can occur in such a lottery are five in number, namely

Occurrence	Frequency
4 black, no white	0.2401
3 " 1 "	0.4116
2 " 2 "	0.2646
1 " 3 "	0.0756
0 " 4 "	0.0081
	1.0000

where the frequencies are the terms of the binomial expansion $(0.7 + 0.3)^4$.

Now suppose that either 4 or 3 balls correspond to an answer *heavier*, 2 to an answer *undecided*, and 1 or 0 to an answer *lighter*. For the stimulus in question the relative frequencies of these will be:

heavier	0.2401 + 0.4116	= 0.6517
undecided		= 0.2646
lighter	0.0756 + 0.0081	= 0.0837
		1.0000

Imagine now this process carried out for a number of urns, thus

Composition of Urn	Frequency of Answers		
	Heavier	Undecided	Lighter
0.0 black	0.0000	0.0000	1.0000
0.1 "	0.0037	0.0486	0.9477
0.2 "	0.0272	0.1536	0.8192
0.3 "	0.0837	0.2646	0.6517
0.4 "	0.1790	0.3458	0.4752
0.5 "	0.3125	0.3750	0.3125
0.6 "	0.4752	0.3458	0.1790
0.7 "	0.6517	0.2646	0.0837
0.8 "	0.8192	0.1536	0.0272
0.9 "	0.9477	0.0486	0.0037
1.0 "	1.0000	0.0000	0.0000

These numbers are the basis of the three curves in Fig. 3 which it will be recognized are very similar to those actually found in psychological experiment. Skew curves are easily obtained by placing the points of division into the categories *heavier*, *undecided*, and *lighter* at unequal distances from the

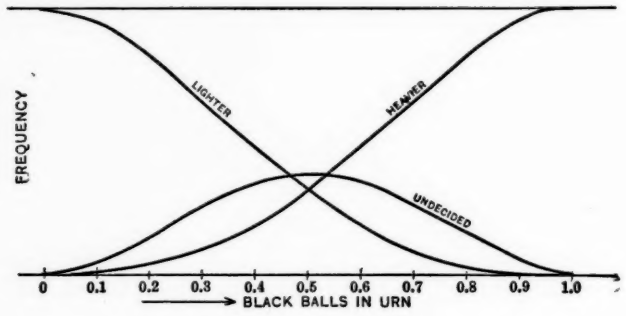

FIG. 3

center of the underlying error curve. The actual form of the curves depends on the way in which the x-axis is measured out. In this diagram the simplest assumption is made, namely, that the proportion of black balls in the urn is a linear function of the stimulus, and, between the limits at which the subject answers heavier or lighter with certainty, directly represents it. The number of balls taken in the sample which represents a judgment is also a factor. But ultimately this would be made very large, and Type III. curves would replace the binomials.

On this point of view, the standard, the variable stimulus, and the physiological make-up of a subject decide the proportion of black balls in the urn, but the decision as to what proportion in the sample is to be called heavier, what undecided and what lighter depends upon a conscious act of the subject, and can be varied, if he be so disposed, at his whim; and will vary with his mood at the moment.

The difference between this point of view and the older one may prove to be academic only,[1] for the disentangling of the factors which are here distinguished may in practice be impossible. Nevertheless the idea seems illuminating, and this sketch is put forward in the hope that some of the resulting curves may prove of interest to mathematical statisticians, and of use in psychophysics.

[1] Indeed it may be that mathematically the one reduces to the other, at any rate under certain conditions.

THE CORRELATION BETWEEN INTERESTS AND ABILITIES IN COLLEGE COURSES

BY JAMES W. BRIDGES AND VERONA M. DOLLINGER

Ohio State University

It is obvious that achievement in any vocation depends partly upon ability to do the work and partly upon interest in that particular kind of work. The latter factor is not less important than the former, for it supplies the necessary incentive to the greatest endeavor. The problem for vocational guidance is therefore to measure ability and interest.

The measurement of ability whether considered as special aptitude or as general intelligence presents no great obstacles. To obtain a test or group of tests whose results correlate highly with actual achievement in any vocation is a relatively simple psycho-statistical problem. The measurement of interest is a much more difficult matter. No objective method is available. The evaluation of interest must therefore depend entirely upon subjective estimate; and of course this estimate cannot be made until the subject has some knowledge of the work.

If it can be shown that interest is highly correlated with ability, the problem of vocational guidance will be simplified; because on the one hand, any interest on the part of the individual will give him definite assurance of ability in that direction, and on the other hand, the presence of a definitely determined ability will surely indicate an interest which perhaps merely awaits experience to be awakened. If however, the correlation is low, as the results of this study seem to indicate, then the practical problem in vocational guidance will be to determine the general ability and special aptitudes of the individual, to advise him as to the several occupations suited to his intelligence level and specific abilities and let him select from these on the basis of his interest, together with other considerations such as social status of the work and remuneration.

The problem of the relation between interest and ability has received considerable attention from educators from time to time; but the only experimental study of the subject known to the writers is that reported by Professor E. L. Thorndike of Columbia University.[1] His subjects, college students, arranged the courses of their curriculum, namely—mathematics, history, literature, science, music, drawing, and other handwork, in the order of their interest and then later in the order of their ability in them. The correlation between these two orders was found to be as high as .89, and the conclusion was drawn that "A person's relative interests are an extraordinarily accurate symptom of his relative capacities."

It seems quite probable that the correlation obtained, .89, is much higher than the actual correlation between interests and abilities, for a subject's ranking of his courses for the one is likely to be influenced by his ranking for the others. Thorndike points out that it would be "Better to get the measurements of relative interest and of ability . . . not from individual reports alone, but from objective tests." A satisfactory objective test for interest is not yet available; but an objective measurement of ability would seem to be afforded by college grades, especially where the proportions of the various grades assigned conform approximately to the normal distribution. It seemed, therefore, desirable to determine the correlation between interests, evaluated subjectively by rankings of courses, and abilities, measured objectively by grades obtained in these same courses.

With this object in view, several hundred students were requested at the beginning of the semester to fill out and return blanks upon which were printed the following instructions: "Arrange the courses you are studying *this semester* according to your interest in them. Place first in the list the course you are most interested in, then the others in order. Please make your judgments carefully and deliberately, and try as far as possible to avoid *influence by class grades* or preference for

[1] 'The Permanence of Interests and Their Relation to Abilities,' *Pop. Sci. Mo.*, 1912, 81.

'Early Interests, Their Permanence and Relation to Abilities,' *School and Society*, 1917, 5.

instructor." Just below a space on the blank for listing the courses a second instruction was given: "Now arrange the subjects you are studying this semester according to your ability in them. Try to make your judgments independent of your interests and of any class grades you may have received." Since these data were obtained near the beginning of the semester, the influence of class grades upon the students' rankings was probably negligible. At the end of the semester the grades actually made by each student on the courses ranked were obtained from the registrar's office. Ranging in order from highest to lowest, the grades used in the university are: M, G, A, P, and F, which are assigned approximately in conformity with the proportions: 5, 20, 50, 20, and 5.

Records were obtained from over five hundred students, and the number of courses ranked varied with different students from four to eight. In order to simplify the calculations only those records with five courses ranked were used since they furnished the bulk of the material.

The relationship between these interests and abilities was determined by means of Pearson's formula for mean square contingency[1] since this seems best adapted to such rough forms of evaluation of traits. The coefficient of mean square contingency (C) thus obtained is somewhat smaller than the coefficient of correlation (r), for in the case of a five by five-fold classification the former (C) cannot exceed .894. However, with coefficients as low as those actually obtained the difference becomes relatively negligible.

The relationship between rank in interest and grade earned was determined first for a specific course of study, namely, elementary psychology. All records that reported psychology were used irrespective of the sex or college year of the student. The data are presented in full in Table I., an inspection of which plainly corroborates the low coefficient obtained (.22). The relationship between rank in interest and rank in ability (as reported by the subject on his record blank, hereinafter referred to as estimated rank in ability) was next determined for the same course, and a coefficient of .59 obtained. Similar coeffi-

[1] See H. D. Rugg, 'Statistical Methods Applied to Education,' pp. 299–307.

TABLE I

RELATION BETWEEN RANK IN INTEREST AND GRADE EARNED IN PSYCHOLOGY[1]

Rank in Interest	Grade					Number Students
	F	P	A	G	M	
1	3	8	14	10	5	40
2	3	10	30	7	9	59
3	2	11	31	17	8	69
4	1	21	30	13	7	72
5	4	10	27	14	4	59
Number students	13	60	132	61	33	299

[1] The letter grades, F, P, A, G, and M, are assigned approximately in conformity with the proportions: 5, 20, 50, 20, and 5; and they have the following meanings: fail, pass, average, good, and merit.

cients were calculated for the English course with very similar results (see Table V.).

Coefficients might have been calculated in the same way for each course reported by the students; but it seemed more desirable to obtain a coefficient that would express the relationship between rank in interest and grade for all courses combined. With this object in view Table II. was prepared from

TABLE II

RELATION BETWEEN RANK IN INTEREST AND GRADE EARNED. ALL COURSES COMBINED

Rank in Interest	Grade					Total
	F	P	A	G	M	
1	6	42	99	58	51	256
2	7	48	113	57	31	256
3	12	53	115	55	21	256
4	13	76	103	50	14	256
5	25	78	106	37	10	256
Total	63	297	536	257	127	1,280

the records of two hundred fifty-six students of both sexes and all college years. The table shows the distribution of grades for the two hundred fifty-six courses placed first in interest, then for the two hundred fifty-six courses placed second in interest, and so on for the third, fourth, and fifth places. The grand total of twelve hundred eighty must accordingly be read as *student-courses*. The coefficient calculated from this table is .25.

The relationship between rank in interest and estimated rank in ability is shown in a similar manner in Table III. Each row of figures gives the distribution in ranks of estimated ability for a given rank in interest for 291 students. The coefficient calculated from this table is .57, which agrees very closely with the similar coefficients for the psychology and English courses.

TABLE III

RELATION BETWEEN RANK IN INTEREST AND ESTIMATED RANK IN ABILITY. ALL COURSES COMBINED

Rank in Interest	Estimated Ability					Total
	5	4	3	2	1	
1	9	19	49	63	151	291
2	18	44	72	94	63	291
3	37	69	69	66	50	291
4	63	102	65	45	16	291
5	164	57	36	23	11	291
Total	291	291	291	291	291	1,455

The low correlation so far indicated between rank in interest and grade and the relatively higher correlation between rank in interest and estimated rank in ability point to the mutual dependence of judgments of interest and of ability. A low correlation between estimated rank in ability and grade might accordingly be expected. Data presenting the actual relation-

TABLE IV

RELATION BETWEEN ESTIMATED RANK IN ABILITY AND GRADE EARNED. ALL COURSES COMBINED

Estimated Rank in Ability	Grade					Total
	F	P	A	G	M	
1	3	26	97	58	44	228
2	7	48	82	62	29	228
3	11	44	112	41	20	228
4	12	61	105	39	11	228
5	20	76	86	38	8	228
Total	53	255	482	238	112	1,140

ship are given in Table IV, and the coefficient was found to be .28, which is very nearly the same as the coefficient for rank in interest and grade.

The relationship between rank in interest and grade and between rank in interest and estimated rank in ability was also determined for each sex separately, and for freshmen and upper class-men separately. The results show no significant differences. Indeed, all the coefficients calculated are surprisingly uniform—a fact which would seem to indicate their general validity. Table V, which sums up all the results,

TABLE V

COEFFICIENTS OF MEAN SQUARE CONTINGENCY (C)

	Between Rank in Interest and Grade		Between Rank in Interest and Estimated Rank in Ability	
	C	No. Cases	C	No. Cases
Psychology	.22	315	.59	158
English	.27	394	.57	194
All courses	.25	256	.57	291
All courses (males)	.26	171	.56	201
All courses (females)	.26	85	.54	90
All courses (1 yr.)	.25	157	.57	185
All courses (2, 3, 4, yr.)	.28	99	.50	106

will facilitate comparison. The coefficient obtained and the number of cases used in each calculation are given.

It will be noted that the contingency coefficients for rank in interest and grade range from .22 to .28, and for rank in interest and estimated rank in ability from .50 to .59. The product-moment coefficient of correlation in the former case would probably not be over .30 and in the latter not over .65. This latter figure is much lower than that obtained by Professor Thorndike (.89) in the experiment referred to above; but, as a measure of the relationship between interest and actual ability, it is probably much too high, and is merely a result of the subjective method of evaluating ability. When ability is measured by a more objective means, namely college grades, a very low correlation between interest and ability is obtained, so low in fact that one might well be justified in the statement: A person's relative interests are an extraordinarily *in*accurate symptom of his relative capacities. It might also be inferred from data here presented that a person's estimate of his ability is an extraordinarily inaccurate symptom of his real ability, for the correlation between the students' rankings of their courses in ability and the grades obtained is only .28.

There are, to be sure, many obvious objections to the use of college grades as measures of ability. First, a grade is also in part a measure of interest since the persistent application which earns the higher grades is based very largely upon interest. The effect of this would be to increase the correlation. That is to say, in so far as the grade earned depends directly upon the incentive supplied by interest, the coefficients given above are too high as measures of the relationship between interests and ability. Secondly, college grades are not sufficiently discriminative; and, consequently, a student may obtain the same grade in all his courses when his actual abilities are perhaps not so even. In so far as this is true, the coefficients reported are too low. Thirdly, grades are also dependent upon general intelligence (if there be one). This would tend to make the grades of each student uniform; and would have the same effect upon the correlation as the factor last mentioned. Finally, grades are also affected by other factors, such as personal relation between student and instructor, outside activities of the student, home environment of the student, and so forth. All these factors would, presumably, affect the correlation adversely.

The writers are therefore not ready to draw any certain conclusions from this short study regarding the actual relationship between interests and abilities. The problem is an extremely complicated one; and it cannot be solved until a more objective method of evaluating interests, as well as abilities, is forthcoming. Achievement, as has already been said depends upon both interest and ability. If these are not highly correlated, the conclusion of practical importance for vocational guidance is that *both must somehow be evaluated separately.*

VISUAL PHENOMENA IN THE DREAMS OF A BLIND SUBJECT

BY RAYMOND H. WHEELER

University of Oregon

The subject whose dreams are herein reported was a student at the University of Oregon from 1915–1918. He was a trained introspector and at the time of this investigation he had had several courses in psychology, including laboratory. After a preliminary period of training in recording dreams he found it possible to describe the important details in note form, in American Braille, immediately upon waking. These notes were subsequently edited by the writer with the help of the reagent, great care being taken to omit all uncertain or otherwise questionable details. The reagent lost his sight by accident when eleven years old. He is now twenty-seven.

Although the primary purpose of this paper is to report visual phenomena in the dream life of a blind subject after sixteen years of blindness, it is interesting to note, in addition, that in his dreams we find a peculiar association between visual images and images in other modalities. In his waking life the subject has very complicated synæsthetic phenomena. It has been noted in the literature[1] that in certain instances those individuals who possess associations between visual and other sensations in their perceptual processes also associate these modalities in a similar fashion in their imaginal processes. This is also true of our reagent. As far as the writer knows, however, such phenomena in dreams have not been described in the literature. For the convenience of the reader the reagent's descriptions of these associations are printed in italics.

DREAM I

First I had a rather confused visual image of a portion of a room including one large window and the surrounding walls. The light which came through the window

[1] To be reported in a subsequent paper.

was dim, giving the appearance of a heavy fog or thick dust which seemed to fill the room. I could distinctly "see" the rays of light penetrating through the fog. The space in the room, penetrated by the light, seemed to be about six feet wide and three feet deep. *Accompanying this visual imagery was a marked unpleasantness*, a vivid organic and kinæsthetic experience consisting of a tension in the muscles of my arm, of a tightening in the vocal cords and of contractions in the muscles of my jaws, the latter resulting in a state of marked rigidity. Then I had a sense of "half pressure and half buzzing" in my ears and a diffuse and vague tension in the muscles of the brows, forehead, neck and chest. *The unpleasantness and kinæsthetic tensions were linked, in consciousness, with the foggy, yellow light.* The second group of experiences constituted an awareness that I was near the walls of the room.

Then I suddenly found myself in a second room in a house some distance away and to the south of the first. Here my imagery was somewhat similar to the preceding but lacking the yellow light and the affective accompaniments. I infer that this house was strange for there was nothing familiar about it. I was then conscious of looking from where I now stood toward the direction of the house I had previously been in. *Simultaneously with this change in my line of regard I had a vague flash of straw-colored light.* This meant "south" to me, which I innervated in vocal-motor fashion: "south." (My notion of "south" is associated, in waking consciousness, with straw-colored light.) I then noticed two friends in the room. Both were sitting to my right and a little in front of me. To my left and very near me was localized a very dark mass, somewhat of the size and general shape of a person, with a thick, hazy area as a fainter background. The lines of his shoulders, chest and arms to the elbows were the only distinct features of the figure. Instantly I had the faintest tendency to turn in his direction. This was the first intimation that I had had of being in this house with a companion. *I was unable to recognize him for the color of the imagery was too faded.* (In waking life I always identify people, in imagery, by their color.)

The friend to my right, seated nearest me was a vague form in sitting position, colored a very deep shade of blue. The only features which approached distinctness were outlines of his head, arms, legs and trunk. I imagine that the form appeared much the same as a person might look through a thick blue lens with the object much out of focus. *The other figure was fawn-colored yellow, of medium brightness and rather poor saturation.* I identified both of these persons by their colors.

Then there appeared a very irregular image of a large oak chair finished with yellow wood and black leather upholstering. The imagery was localized and distributed in space in a position corresponding to the details of a chair which are visible to the eye when one is sitting. I also had tactual imagery of the "feel" of the upholstering and kinæsthetic imagery of the bodily position assumed in sitting in this style of furniture.

I was then conscious of saying: "Hello boys; when did you get in?" There was no answer. My attention then became more rigidly fixed upon the two visual forms as I thought to myself in verbal imagery: "Why don't they answer?" I then spoke again: "I want you fellows to come over and see me while you are here." Again no answer. I then became very angry; I was conscious of intense tightening of muscles in my arms and chest together with a characteristic tension in the back of my scalp. (This latter is characteristic of anger in waking life.) *With the growing anger the colors of the two forms became very much brighter.* I then turned to the figure at my left, which represented my companion, and said: "Let's go back." I then found myself back in the first house but this time in a different room, for the window was on the

west side and there was a telephone on the wall. The window curtains were streaks of drab-grey, which, I suspect, is my representation of white. The room was large, which I interpret from the fact that I experienced no pressure images. My awareness of the telephone consisted of visual and tactual imagery. I "saw" the brownish wooden box containing the mechanism of the telephone. In the middle of the transmitter was a circle of rather brilliant light which told me the exact place into which to direct my voice. The hard rubber mouthpiece was visualized as black; the receiver hook was a shining steel-gray as were also the bells. The outlines of these objects were fairly distinct but fleeting. I then had the vocal-motor: "I will call up the boys and ask them over to see me." I had kinæsthetic and tactual imagery of taking down the receiver and of holding it to my ear, with a distinct image of coldness as the edge of the receiver came in contact with my ear. No further imagery appeared until the vocal-motor: "They won't answer," whereupon I was extremely disappointed and angry. Here I had the characteristic sinking experiences localized in the region of the diaphragm, inhibition of breathing and tensions in the throat and chest. I then had the vocal-motor: "You can go straight to the devil." *At this moment I became conscious of a person in back of me, visualized as a bright and silvery form,* which meant to me that the form was a woman. I then had auditory imagery of her voice: "He has drowned in the creek." Simultaneously with the "he" there appeared *a dark visual schema to my right, very indistinct and not sufficiently colored for identification.* I next found myself searching for the creek. I was visualizing myself walking up a slope along a winding path. My consciousness of surrounding objects consisted only of kinæsthetic imagery of shrinking, dodging or otherwise avoiding branches, rocks and trees. I was distinctly conscious of an awkwardness with tensions in the trunk, legs, face and shoulders, all of which contributed to an awareness that I was uncertain where to step. I then found myself at a gate. I stepped back and watched a visual image of myself looking over the gate up the hill. Suddenly I lost the "visual me" and was looking at the gate at close quarters. The transition was almost instantaneous. I now visualized the two gate posts distinctly, together with the braces attached to the top of each post. Just beyond the braces was the woven wire, silvery in color, as if it had been galvanized recently. I was then conscious of fingering the wires, at which instant the visual imagery became more distinct. I was aware, next, that just beyond the gate was a hill. I did not visualize the hill distinctly; it was merely a brownish haze—a color which represents rank undergrowth to me; but I was distinctly conscious of tactual and auditory imagery of being in the shadow of a hill. The tactual experiences refer to changes in temperature and the auditory to changes in echo. I retraced my steps down the hill and while on the way noticed a group of oak trees which I had "seen" on my way up. I visualized their peculiar dark brown trunks, knotted and gnarled, and had tactual imagery of running my hand over the bark, covered with moss and lichens. I could see upward as far as the first branches but beyond that the trees faded into a hazy background, thence into nothingness. The brown of the trunks was faded and dim, the color irregular in distribution, giving the effect of a pouring rain on a window pane—a "wiggly" appearance.

At this point in the dream I was conscious of the person who went with me to the second strange house. This consisted of *a colored visual schema at my left, too vague, however, to identify,* and also of a peculiar motor "start," characteristic of a sudden consciousness of a person near you. We had a short conversation concerning the oak trees, the details of which I cannot remember. I recall that both his words and mine were in my own verbal imagery.

I next found myself at the edge of the creek, vividly aware that I was facing the creek and that the first strange house I had entered was back of me. *This was present in terms of a faint brownish haze off at the horizon back of me.* The water in the creek was sluggish and a dark opaque, oily green. The water almost overran the banks. Next to the edge of the stream I visualized masses of dead, pale, straw-colored grass, most of which was very hazy except for the larger tufts in which latter I seemed to "see" some of the individual blades. The grass lined both banks of the stream and extended over into the water. Suddenly I "saw" a collar and necktie floating down the stream, too far out to be reached. I viewed them indifferently until I had the vocal-motor: "It is *A's* collar!" Upon experiencing the verbal imagery I was conscious of intense grief, represented by marked feelings of stuffiness in my chest and by tendencies to sob. I awoke and actually found myself sobbing. Although I did not notice it particularly at the time, I am certain, on recalling the imagery of the collar, that it was white. The tie was blue with large brown bands running diagonally across it. I could not "see" those portions of the objects below the surface of the water.

DREAM 2

I was seated in a passenger coach, midway between the ends, on the right side of the car and next to the window. I could "see" the vague form and outline of the sun-bleached red plush seat directly in front of me. For some little distance in front I could distinguish the yellow woodwork between the windows but farther down the coach the woodwork became very indistinct. A brilliant light was shining through the windows, illuminating the coach. Mixed with the visual images of the plush seats were tactual images of the friction of my trousers as they adhered to the plush, preventing me from making slight movements with ease. I also had clear tactual imagery of my arm as it rested in the sill of the car window.

The objects in the surrounding country were vague and fleeting and seemed to pass by very rapidly. They were of the brightness and tint of vegetation in the sandy desert. Now and then I was conscious of vague outlines of the rolling hills, stretching out in the far distance. I was travelling northeast, *indicated to me by a large area of dense blackness which was projected beyond the side of the car off to the front and to the left.* This dark or black horizon meant north. The relation of the black schema to the side of the car I interpreted to mean northeast. Then I noticed that my position in the coach had changed. I was riding backward. *The dark cloud was now at my back and to my right.* I became conscious that my brother was with me. This was in terms of *a gray splotch about the size of a man, in sitting position opposite me.* My brother said: "We are coming to the Blue Mountains." Although he seemed to be speaking these words, for I was listening in his direction, the words themselves came to me in my own verbal imagery.

Looking out of the window to my left I visualized a range of steep mountains rising abruptly from the desert. Here the brightness of the landscape greatly increased; various vaguely outlined hills passed by the window rapidly; the hills toward the south were dark blue, fading into a dull grey the nearer they were to me. Mixed with the awareness of this blue schema was a tactual image of tall thick grass soaked with rain. As the number of hills increased I was conscious of a distinct feeling of relief, referred to muscular relaxations about the brows, eyes and jaws. The thicker the hills became, the more marked became the relief until it merged into wonder and surprise. The muscles of my chest became tense; I was conscious of tendencies to smile. I noticed that on the sides of the nearest hills there were dark patches. Then I vocal-

ized my brother's words as he spoke again: "The dark places are where they graze their sheep. The dry and sandy places are where the coyotes live." Following these latter words I had fleeting visual images of a comparatively level stretch of ground, covered with innumerable greyish rocks, scattered thickly over a faded, yellowish-brown soil.

DREAM 3

I was in the middle of a river, astride a log. All about me the water for twenty or thirty feet was jet black and so dense that I could not "see" below the surface. The log was about eight inches in diameter and quite distinctly visualized as an old alder snag which was smooth, with no bark and a very light grey in color. The size of the log is an interpretation partly from the visual image and partly from the extent to which it protruded out of the water. Its smoothness was present to consciousness partly as an interpretation from the visualized surface and partly from the fact that my legs were adjusted in such fashion as to prevent my slipping on the surface.

I had very distinct motor imagery of balancing myself. This involved my legs, trunk and arms. I judge that I was about one third of the distance back from the front end of the log which I gather from the manner in which the log responded to my movements. I was going down stream rapidly. This latter consciousness came to me in terms of a visual image of a dark, ribbon-like streamer indicating how the water was being "cut" by the passage of my feet through it. I also had tactual imagery of water rushing rapidly by my hand, an experience similar to the sensations one receives when placing his hands in the water as he rides in a fast boat. Together with this latter visual imagery was auditory imagery of the swishing of the water. I do not know how fast the current was flowing but I seemed to be travelling faster than the stream. I had tactual-kinæsthetic imagery of being hurled rapidly through space in the direction of down-stream.

All about me, especially to the left and in front, small fish, about ten inches long, were continually jumping out of the black, inky water. They leaped only a few inches above the surface, looked at me and disappeared with a croak. I could not visualize the fish clearly but merely got their general shape and size. Sometimes they would appear only on the surface of the water; they would extend their heads upward until their gills appeared when they would utter a peculiar sound and disappear again. In many instances I had *auditory imagery of their croaks together with a flash of yellow light, hovering, temporarily, about the region of their mouths. In other instances I was aware only of the yellow light, which, however, meant to me that they were making their peculiar sounds.* Some of the fish were striped grey and black, the stripes running across their sides from the lower front to the upper back, thus making diagonal bars across their bodies. I was next conscious of the vocal-motor: "These are singing carp." Then I had a visual image of a fish net lying upon the log in front of me, and the vocal-motor: "I have a net and will get some."

DREAM 4

I was under the south end of a bridge. I was facing the south with the stream in back of me. I have a very distinct remembrance of visualizing the supports of the bridge as I looked through them *toward a cloud of yellow light off in the distance. This cloud of yellow light meant south.* I did not visualize the bridge above me but was aware in auditory terms of the faint echo and in tactual terms of the nearness of the bridge to me. I then had visual and kinæsthetic imagery of piling rocks into a gunny sack. I was greatly disturbed both by the fear of getting caught and by my bull-

dog which kept barking, and pulling vigorously at my trouser's leg. Here the tactual and auditory imagery was profuse and clear. *The imagery of the dog's form was indistinct save for a bright straw-colored schema which always represents this dog to me.* I was holding one corner of the sack with my left hand (tactual, motor and visual imagery) and the sack itself was a dark yellowish-brown. I could not "see" the weave and did not notice any tactual imagery of it. Then there appeared the verbal imagery: "I want *A* to see these before anyone finds me." Then I was vividly aware of the fact that *D* might find me. This consisted of tenseness about the chest and abdomen, with "sinking sensations" in the region of my stomach. *D was represented to me in terms of peculiar flashes of color which corresponded to his voice.* I then awoke.

Three striking peculiarities stand out in the dreams given above. First is the appearance of associations between visual and other sense modalities, which, in every instance conform to synæsthetic phenomena in the reagent's waking life. Schematic forms of persons are identified by color. Persons' voices are recognized by their color; directions of the compass, the "croaking" of the singing carp, the bull dog, are all identified by certain colors. The reagent's auditory imagery is exceedingly deficient both in dream and in waking life but this deficiency is largely compensated for by visual associations or synæsthetic phenomena.

Secondly, our subject has the peculiar tendency to vocalize the spoken words of another person's voice in terms of his own vocal-motor imagery. Colors provide the necessary qualitative differences for identification. This is true both of waking and of dream consciousness. Verbal imagery is very rarely syncopated or abbreviated and is very definite in details of enunciation and of expression.

Thirdly, there is to be noticed a peculiar tendency, in the subject's dreams, to visualize himself at a distance. Various details, which the writer has been able to obtain on this point, indicate that the subject often has a "visual me" in dreams. This "visual me" is evidently a product of repeated tendencies on the part of the subject to visualize himself as he walks about in order to ascertain, if possible, whether he showed his blindness in any peculiarities of walking. This "visual me" appears to him frequently, in dreams, if he is conscious of being watched. The visualized figure consists mostly of hands and feet, separated and in movement as if in walking. Peculiar feeling complexes are associ-

ated with this visual imagery but otherwise the experiences have not been definitely analyzed. Occasionally this "visual me" appears close to the subject but it is usually localized some distance away.

Visual imagery still outnumbers other modalities both in the subject's dreams and in his waking life. This imagery has now become vague in form and outline. For example, persons lack outlines of eyes, mouth, ears, fingers, and details of trunk and legs. The size and duration of the imagery, however, have remained practically normal. Visual imagery of small objects similarly lacks definiteness but possesses a greater degree of clearness than does visual imagery of larger objects. This is undoubtedly due to the fact that the act of handling small objects makes it easier for the reagent to visualize them. In fact, when the subject wishes to visualize an object clearly he always endeavors to explore it in tactual-motor fashion. In the first dream it will be noticed that as soon as the reagent found himself fingering the wire in the fence, its color increased in vividness and the outlines of the visual imagery became more distinct.

All visual imagery lacks details as well as form and outline. The room visualized in the first dream was devoid of furniture. In like manner were lacking the details of the telephone, the lace curtains, the chair, the scenery along the path, the trees, bushes, clothing, etc. A hill is a mass of color with light and dark patches; mountains are clouds of color; water is lacking in detail of wave or brightness; trees are visualized only in part, and so on.

Taking the place of details in visual imagery are auditory-vocal-motor, tactual and kinæsthetic-organic experiences. For example, the visual imagery of oak trees in dream 1 is pieced out with tactual imagery of exploring the surface of the trunk. The visual imagery of being seated in a chair is supplemented by tactual imagery. The same is true of talking through a telephone.

Kinæsthetic imagery is exceedingly clear and persistent. In many instances the reagent has hesitated in calling these experiences "images" owing to their vividness, and dis-

tinctness of localization. Such imagery is very readily recalled. Organic complexes constitute an important feature of our reagent's dreams. While experiencing joy, for instance, he feels the characteristic changes in respiration, the tendencies to smile, and the pleasantness; while in fear he is able to detect the tensions in the throat, the organic changes from the regions of the stomach and diaphragm, and the altered breathing. Again, in anger he is aware of the jaw tensions, the tightness of arms and hands, and the changes in facial expression, all of which seem to be exact copies of experiences in waking life. Organic processes seem to be recalled with greater readiness than visual details.

We believe that the above descriptions demonstrate that the introspective method—at least the terminology—can be applied in the description of dreams. Whereas it may be contended that the chief interest in dreams pertains to their function rather than to their content, it is obvious that the significance of dreams can be much better understood if their content is first described in minute detail. Such descriptions should be obtained by using a method patterned after introspection rather than after interpretation.